

ANALOG

SCIENCE FICTION AND FACT

DECEMBER 2009

**Formidable
Caress**

Stephen Baxter

H. G. Stratmann
Richard A. Lovett
G. David Nordley

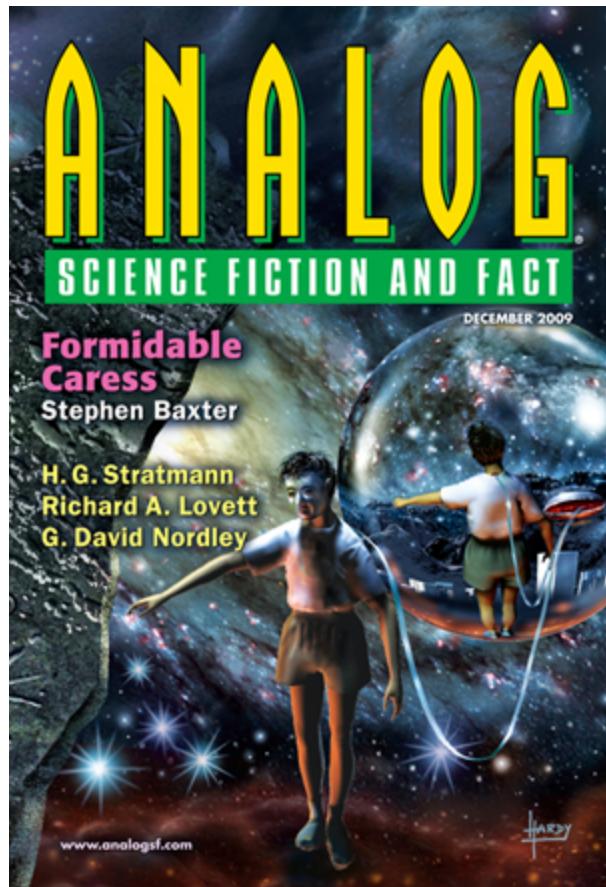
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Reader's Department: **EDITORIAL: CONTROL** by Stanley Schmidt

One of John W. Campbell's most famous editorials in *Astounding* looked at what was once a popular basis for science-fictional plots—and why it probably wouldn't work in reality. He was right, but I don't think he went far enough.

The idea was that human scientists or engineers would get their hands on a technological artifact from their own future, or from an alien civilization, and figure out how it worked and how to duplicate or even improve on it. In "No Copying Allowed" (November 1948), John demonstrated the improbability of this premise with a simple hypothetical example.

Suppose, he suggested, that a late 1940s guided missile screamed across a 1920 sky and into the hands of a team of U.S. Army Signal Corps engineers. It represents a technology less than thirty years beyond their own, but it's full of things they can't understand. It flies much faster than anything they've seen, yet doesn't seem to have an engine—just a simple pipe, open at both ends. We'd recognize it as a ramjet, but they don't yet have that idea—not surprising, since a ramjet won't even work unless it's already moving faster than anything that could be built in 1920. It's made of alloys of unfamiliar composition and structure, and contains electronic components that they can recognize, in a general way, but not reproduce, such as printed circuits and tiny vacuum tubes, resistors, and capacitors. There are also mysterious little objects made of solid germanium and functioning as amplifiers, but exact copies made with the purest available germanium do nothing (because, we would say, they lack the necessary "doping" with tiny amounts of just the right impurities).

And so on.

Looking back at John's scenario from sixty years after he wrote his editorial, we have a different perspective in at least two major ways. First, wildly advanced and incomprehensible as his 1948 missile would have seemed to engineers of less than thirty years earlier, it now looks pretty quaint to us. It used vacuum tubes, for one thing—a technology now so

widely forgotten that many young scientists and engineers have never seen one. (Several years ago, a young physicist at Bell Labs told me he'd always regarded vacuum tubes as rather mysterious substitutes for transistors; which, in reverse, is pretty much how I felt about transistors after having learned vacuum tubes first.) Those mysterious germanium amplifiers in Campbell's hypothetical specimen *were* transistors, but they were *discrete* transistors, something we seldom see anymore. If the engineers who built and launched that missile in 1948 got hold of one of our missiles—or even many of our toys!—they would have found it full of high-level integrated circuits, each the size of one of their transistors, but incorporating *millions* of them (plus associated circuitry). But they would have been hard put to recognize them as such, and had no hope of building anything similar.

The second way in which John's example looks different to us is that his engineers were trying to analyze and reproduce the inner workings of the gadget that had fallen into their midst. I think they would have had trouble long before that point. Even the external controls—what we would now call the user interface—would have been less than intuitive. And even if those of 1948 would have been reasonably easy for a user of 1920 to figure out, the ones we use now would surely have been baffling for at least a goodly while.

Consider what controls on electronic devices typically looked like in 1920 or 1948. In 1920, most units would have a simple set of functions and a simple set of controls, each with a single function and a straightforward correlation with that function. A radio, for example, would be designed to receive a signal within a single rather narrow band of radio frequencies, demodulate it to extract the audio-frequency signal the radio wave “carried,” and amplify that audio signal to drive a headphone or speaker at the desired volume. The controls would be an on-off switch, a tuning dial, and a volume control. Tuning was typically done with a variable capacitor rotated by a knob directly coupled to a circular dial to indicate frequency, or driving a string to move a pointer along a linear frequency scale. Either way, there was one knob that did nothing except select frequency and one indicator that did nothing except show the frequency. If other indications were needed, such as signal strength, that was done by an analog meter, with a needle pointing to the current value of that variable on a printed

scale. The on-off switch could be a toggle or slide, or a push-button, or a rotary switch that clicked off counterclockwise and on clockwise. The closest such a device was likely to get to combining functions in one control was fairly common but simple: a rotary or push-button on-off switch might be combined with the volume control in a single knob. That made straightforward sense since “off” can be thought of as the ultimate stage of “down” and “on” as the first step “up.” With that semi-exception, each control did one and only one operation, and there was no other way to do that.

Things hadn't changed all that drastically by 1948, which is probably why Campbell didn't mention the additional difficulty I'm pointing out today. But they had changed significantly. Electronic devices had become more versatile and controls had begun “multitasking” to accommodate that fact. A radio might now cover not just a single AM band, but several of widely different frequency ranges (broadcast and shortwave), plus another using frequency modulation (FM). It might also have an input allowing a phonograph record to be played through its audio stages. So it would need at least one selector switch, most likely a rotary switch with a knob pointing to AM, FM, SW1, SW2, SW3, or PHONO. The tuning dial would still have one pointer but several parallel scales, each labeled to correspond to one of the selector positions, so it wouldn't be too hard to figure out which of the several simultaneous indications was relevant. The volume control would still be a volume control, regardless of the selector position. There might also be a tone control, or perhaps two (treble and bass). If the radio was powered up and working, the function of each control could quickly be determined by experiment, even if the experimenter couldn't read the markings. If it was not powered, there'd be more guesswork involved.

But now, fast-forward to 2009 and try to imagine one of our radios, computers, cellphones, or iPods falling into the hands of Campbell's 1920ish engineers. First off, a radio that's just a radio is something of a rarity these days. The one in my car is also a CD player and an audiocassette player, and it only has two knobs: one labeled VOLUME and one labeled MODE. Everything else is push buttons and a couple of rocker switches, and most of the indicators are digital liquid-crystal displays that aren't even visible when the thing is turned off. When it's on, what the

displays show is completely different depending on which modes of operation are chosen with the push buttons—and even what the push buttons choose is different depending on what other choices have already been made.

Given suitable power to operate the thing, a good engineer from either 1920 or 1948 could eventually figure out how to use it, but I think he'd go through a good deal of head-scratching and hair-pulling first. Its whole psychological framework for relating controls to functions is radically different from what he was used to. He'd probably start with the VOLUME knob, the only thing there that looked and sounded like anything familiar. He would be reassured to confirm that it does indeed control volume, and pushing it turns the unit on or off. But eventually he'd discover that it can also be turned on—but not off, and only sometimes on—by any of the pushbuttons labeled AM, FM, CD, or TAPE. (If there's a CD or tape in the relevant slot, pressing the corresponding button turns the system on and starts playing the indicated object wherever it was last stopped. Pressing CD while playing a tape immediately switches to playing the loaded CD, if there is one. Pressing CD when the unit is off and no CD is loaded does nothing.)

Not knowing about CDs or tapes, our intrepid engineer (at least the one from 1948) would probably start by trying the FM or AM button, since those are at least recognizable terms. He still wouldn't see a recognizable tuning dial; just, say, "FM1" and a single number like "96.3." The 1948 engineer might say, "Aha! That sounds like an FM frequency," and rightly conclude that he was on the right track; for the fellow from 1920, it wouldn't ring any bells (or bring in any stations). Either of them might discover by experiment that the rocker switch labeled TRACK/TUNE would make the displayed number go higher or lower (depending on which end was pressed), and that for some numbers sound came from the speakers, presumably from different radio stations. At that point he might start feeling a little smug, thinking he'd discovered "the future's" version of a tuning dial—until he noticed that the SEEK button caused the frequency numbers to scroll up automatically and stop on any signal strong enough to lock in; while SCAN made it scroll up, pause for a few seconds whenever it found a usable signal, and then resume scrolling unless he pressed it again

right away. He'd also find that a row of pushbuttons labeled only with single-digit numbers printed on them each jumped immediately to a different frequency—and pressing FM again caused those same buttons to yield a whole different set of frequencies.

If he was lucky enough to find a CD or tape along with the radio/player, he probably wouldn't take too long to figure out where to put it in and discover that it also made sound came out if he pressed the right button (or, in the case of the CD, even if he didn't). He would also discover that the display had completely changed. Now, instead of "FM1" or "FM2," part of it would say "TAPE" or "CD"; part would be a number like "3" or "11"; part would look like the reading on a running stopwatch, counting seconds; and part, at the very bottom, would be a series of geometrical shapes, like single or double arrowheads, squares, and parallel vertical lines, each above one of those numbered push buttons. In these modes, the numbers printed *on* those buttons have nothing to do with their functions; now, instead, of jumping to preselected radio stations, they do things like PLAY, REWIND, FAST FORWARD (within a track, for CDs), or SWITCH TO THE OTHER SIDE OF THE TAPE, and the display icon above each button tells which of those things it now does. And that TRACK/TUNE rocker now jumps to an earlier or later track on a CD.

If the tone quality didn't suit his tastes, he still wouldn't see a recognizable TONE, TREBLE, or BASS control; but he might eventually discover that repeatedly pressing the MODE knob caused it to cycle through displays including TREB, BASS, BAL, and FADE. When one of those was showing, rotating the same knob would vary the treble, bass, and relative amounts of sound coming from left or right and front or back. Except if he didn't start rotating it within a few seconds, that display would vanish and turning that knob would do nothing.

Most of us now are used to this sort of thing, so it seems relatively natural. There's enough variation in detail among models and manufacturers that it can still be helpful to read the instructions, but we're sufficiently accustomed to these general ways of doing things that most of us could figure out the details of an unfamiliar model without too much trial and error if we had to. But I can well imagine that the initial reaction of

anybody in 1920, or even 1948, would be to think that somebody had put an awful lot of effort into making this thing fiendishly complicated and hard to use.

And just imagine his reaction if all he found was the remote for a television set, without realizing that it was just a control box for something else rather than a self-contained device intended to do something useful on its own!

Or an iPod, which would seem at first glance to have almost no controls at all. Or the laptop computer on which I'm writing this.

The kind of computer most of us now take for granted is an extreme example—at least, by past and present standards—of a simple-looking device that can do so many different things that probably no individual has ever been thoroughly familiar with all of them. At first glance, it's just a small box with a display screen and what looks like an old-fashioned typewriter keyboard, with a few extra keys with cryptic labels like “ctrl,” “esc,” or pictures of fruit. So how can it do so many things, each of which can be accomplished in at least two or three different ways? Part of it is by combining the regular keyboard keys with the special ones to make executable commands, but what a particular key combination does depends on what application (program) is currently active and even what part of it you're using. In one database program, for example, “Command-N” can mean “Create a new record” in “Browse” mode or “Make an additional search request” in “Find” mode. In “Finder,” an application used for switching among applications and documents, the same keyboard command means “Create a New Folder.” In at least one word processor I've used, it means “Create a new blank document.” Most of these commands can also be given by choosing a verbal description from a pull-down menu on the display screen, using a mouse or trackpad; or by clicking on one of the colorful little icons that abound on the screen (and vary from program to program).

I suspect all this would have been wildly intimidating to those engineers of 1920 or 1948, even though to many of us now it seems refreshingly straightforward compared to the computer interfaces we had to deal with, say, three decades ago. That's because, depending on our age and background, we've either grown up with this sort of interface, or coevolved

with it so we can appreciate what an improvement it is over its predecessors. Most of us are now so accustomed to seeing hyperlinks on a screen that will take us to information we're seeking, that if we're using an unfamiliar website, we'll automatically look around on the screen for something that sounds likely to take us where we want to go. But 'twas not always thus. When I bought my first computer, more than twenty years ago, it came with a printed manual that went into great detail on such basics as how to use a mouse. New computers can do far more, but come with skimpier manuals that take most of that for granted. The "real" manual is the onscreen help menu, and readers are pretty much expected to be able to use the keyboard and mouse or trackpad to find their way around that. For an adult starting from scratch, I suspect getting started with a new computer can still be intimidating.

And something from sixty years in our future, or from an independently evolved but comparably developed civilization, would likely be a real challenge for any of us. Considering how radically the ways we interact with our machines have changed in the last few decades, and how many things are evolving faster now than ever, I see a good chance that control systems from the latter part of this century will be so different from the ones we use now that it might be hard for us to recognize them, much less figure out how to use them. As Arthur C. Clarke famously observed, "Any sufficiently advanced technology is indistinguishable from magic."

But it will still be fun to see our science fiction writers trying to imagine what such systems *might* be like.

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Novelette: **FORMIDABLE CARESS** by Stephen Baxter

Some things are inherently beyond the scope of human experience—unless there's a really big loophole

As the women tried to pull her away, Ama hammered with her fist on the blank wall of the Building. "Let me inside! Oh, let me inside!"

But the Building had sealed itself against her. If the Weapon decreed that you were to have your child in the open air, that was how it was going to be, and no mere human being could do anything about it.

And she could not fight the logic of her body. The contractions came in pulses now, in waves that washed through the core of her being. In the end it was her father, Telni, who put his bony arm around her shoulders, murmuring small endearments. Exhausted, she allowed herself to be led away.

Telni's sister Jurg and the other women had set up a pallet for her not far from the rim of the Platform. They laid her down here and fussed with their blankets and buckets of warmed water, and prepared ancient knives for the cutting. Her aunt massaged her swollen belly with oils brought up from the Lowland. Telni propped her head on his arm, and held her hand tightly, but she could feel the weariness in his grip.

So it began. She breathed and screamed and pushed. And through it all, here at the lip of the Platform, she was surrounded by her world, the Buildings clustered around her, the red mist of the Lowland far below, above her the gaunt cliff on which glittered the blue-tinged lights of the Shelf cities, and the sky over her head where chains of stars curled like windblown hair. On Old Earth time was layered, and when she looked up she was peering up into accelerated time, at places where human hearts fluttered like songbirds'. But there was a personal dimension to time too, so her father had always taught her, and these hours of her labor were the longest of her life, as if her body had been dragged down into the glutinous, redshifted slowness of the Lowland.

When it was done, Jurg handed her the baby. It was a boy, a scrap of flesh born a little early, his weight negligible inside the spindling-skin blankets. She immediately loved him unconditionally, whatever alien thing lay within. "I call him Telni like his grandfather," she managed to whisper.

Telni, exhausted himself, wiped tears from his crumpled cheeks.

She slept for a while, out in the open.

When she opened her eyes, the Weapon was floating above her.

It was a sphere as wide as a human was tall, reflective as a mirror, hovering at waist height above the smooth surface of the Platform. She could see herself in the thing's heavy silver belly, on her back on the heap of blankets, her baby asleep in the cot beside her. A small hatch was open in its flank, an opening with lobed lips, like a mouth. From this hatch a silvery tongue, meters long, reached out and snaked to the back of the neck of the small boy who stood beside the sphere.

Her aunt, her father, the others hung back, nervous of this massive presence that dominated all their lives.

The boy attached to the tongue-umbilical took a step towards the cot.

Telni blocked his way. "Stay back, Powpy, you little monster. You were once a boy as I was. Now I am old and you are young. Stay away from my grandson."

Powpy halted. Ama saw that his eyes flickered nervously, glancing at Telni, the cot, the Weapon. This showed the extent of the Weapon's control of its human creature; somewhere in there was a frightened child.

Ama struggled to sit up. "What do you want?"

The boy Powpy turned to her. "We wish to know why you wanted to give birth within a Building."

"You know why," she snapped back. "No child born inside a Building has ever harbored an Effigy."

The child's voice was flat, neutral—his accent like her father's, she thought, a little boy with the intonation of an older generation. "A child without an Effigy is less than a child with an Effigy. Human custom concurs with that, even without understanding—"

"I didn't want *you* to be interested in him." The words came in a rush. "You control us. You keep us here floating in the sky. All for the Effigies we harbor, or not. That's what you're interested in, isn't it?" Telni laid a trembling hand on her arm, but she shook it away. "My husband believed his life was pointless, that his only purpose was to grow old and die for you. In the end he destroyed himself—"

"Addled by the drink," murmured Telni.

"He didn't want *you* to benefit from his death. He never even saw this baby, his son. He wanted more than this!"

The Weapon seemed to consider this. "We intend no harm. On the contrary, a proper study of the symbiotic relationship between humans and Effigies —"

"Go away," she said. She found she was choking back tears. "Go away!" And she flung a blanket at its impassive hide, for that was all she had to throw.

The Weapon came to see Telni a few days after the funeral of his mother and grandfather. He was ten years old.

Telni had had to endure a vigil beside the bodies, where they had been laid out close to the rim of the Platform. He slept a lot, huddled against his kind but severe aunt Jurg, his last surviving relative.

At the dawn of the third day, as the light-storms down on the Lowland glimmered and shifted and filled the air with their pearly glow, Jurg prodded him awake. And, he saw, his mother was ascending. A cloud of pale mist burst soundlessly from the body on its pallet. It hovered, tendrils and billows pulsing—and then, just for a heartbeat, it gathered itself into a

form that was recognizably human, a misty shell with arms and legs, torso and head.

Jurg, Ama's sister, was crying. "She's smiling. Can you see? Oh, how wonderful..."

The sketch of Ama lengthened, her neck stretching like a spindling's, becoming impossibly long. Then the distorted Effigy shot up into the blueshifted sky and arced down over the lip of the Platform, hurling itself into the flickering crimson of the plain below. Jurg told Telni that Ama's Effigy was seeking its final lodging deep in the slow-beating heart of Old Earth, where, so it was believed, something of Ama would survive even the Formidable Caresses. But Telni knew that Ama had despised the Effigies, even the one that turned out to have resided in her.

They waited another day, but no Effigy emerged from old Telni. So the bodies were taken across the Platform, to the center of the cluster of box-shaped, blank-walled Buildings, and placed reverently inside one of the smaller structures. A week later, when Jurg took Telni to see, the bodies were entirely vanished, their substance subsumed by the Building, which might have become a fraction larger after its ingestion.

So Telni, orphaned, was left in the care of his aunt.

She tried to get him to return to his schooling. A thousand people lived on the Platform, of which a few hundred were children; the schools were efficient and well organized. But Telni, driven by feelings too complicated to face, was restless. He roamed, alone, through the forest of Buildings. Or he would stand at the edge of the Platform, before the gulf that surrounded the floating city, and watch the Shelf war unfold, accelerated by its altitude, the pale blue explosions and whizzing aircraft making an endless spectacle. He was aware that his aunt and teachers and the other adults were watching him, concerned, but for now they gave him his head.

On the third day he made for one of his favorite places, which was the big wheel at the very center of the Platform, turned endlessly by harnessed spindlings. Here you could look down through a hatch in the Platform, a hole in the floor of the world, and follow the tethers that attached the

Platform like a huge kite to the Lowland ground half a kilometer below, and watch the bucket chains rising and falling. The Loading Hub was directly beneath the Platform, the convergence of a dozen roads crowded day and night. Standing here it was as if you could see the machinery of the world working. He liked to think about such things, as a distraction from thinking about other things. And it pleased him in other ways he didn't really understand, as if he had a deep, sunken memory of much bigger, more complicated machinery than this.

Best of all you could visit the spindling pens and help the cargo jockeys muck out a tall beast, and brush the fur on its six powerful legs, and feed it the strange purple-colored straw it preferred. The spindlings saw him cry a few times, but nobody else, not even his aunt.

When the Weapon came to see him he was alone in one of the smaller Buildings, near the center of the cluster on the Platform. He was watching the slow crawl of lightmoss across the wall, the glow it cast subtly shifting. It was as if the Weapon just appeared at the door. Its little boy stood at its side, Powpy, with the cable dangling from the back of his neck.

Telni stared at the boy. "He used to be bigger than me. The boy. Now he's smaller."

"We believe you understand why," said Powpy.

"The last time I saw you was four years ago. I was six. I've grown since then. But you live down on the Lowland, mostly. Did you come up in one of the freight buckets?"

"No."

"You live slower down there."

"Do you know how much slower?"

"No."

The boy nodded stiffly, as if somebody was pushing the back of his head. "A straightforward, honest answer. The Lowland here is deep, about half a kilometer below the Platform, which is itself over three hundred meters below the Shelf. Locally the stratification of time has a gradient of, approximately, five parts in one hundred per meter. So a year on the Platform is—"

"Only a couple of weeks on the Lowland. But, umm, three hundred times five, a year here is fifteen years on the Shelf."

"Actually closer to seventeen. Do you know *why* time is stratified?"

"I don't know that word."

Powpy's little mouth had stumbled on it too, and other hard words. "Layered."

"No."

"Good. Nor do we. Do you know why your mother died?"

That blunt question made him gasp. Since Ama had gone, nobody had even mentioned her name. "It was the refugees' plague. She died of that. And my grandfather died soon after. My aunt Jurg says it was of a broken heart."

"Why did the plague come here?"

"The refugees brought it. Refugees from the war on the Shelf. The war's gone on for years, Shelf years. My grandfather says—said—it is as if they are trying to bring down a Formidable Caress of their own. The refugees came in a balloon. Families with kids. Grandfather says it happens every so often. They don't know what the Platform is, but they see it hanging in the air, below them, at peace. So they try to escape."

"Were they sick when they arrived?"

"No. But they carried the plague bugs. People started dying. They weren't im—"

"Immune."

"Immune like the refugees."

"Why not?"

"Time goes faster up on the Shelf. Bugs change quickly. You get used to one, but then another comes along."

"Your understanding is clear."

"My mother hated you. She was unhappy when you visited me that time, when I was six. She says you meddle in our lives."

"'Meddle.' We created the Platform, gathered the sentient Buildings. We designed this community. Your life, and the lives of many generations of your ancestors, have been shaped by what we built. We 'meddled' long before you were born."

"Why?"

Silence again. "That's too big a question. Ask smaller questions."

"Why are there so many roads coming in across the Lowland to the Loading Hub?"

"I think you know the answer to that."

"Time goes twenty-five times slower down there. It's as if you're trying to feed a city twenty-five times the size."

"That's right. Now ask about something you don't know."

He pointed to the lightmoss. "Is this the same stuff as makes the light-storms, down on the Lowland?"

"Yes, it is. That's a good observation. To connect two such apparently disparate phenomena—"

"I tried to eat the lightmoss. I threw it up. You can't eat the spindlings' straw either. Why?"

"Because they come from other places. Other worlds than this. Whole other systems of life."

Telni understood some of this. "People brought them here, and mixed everything up." A thought struck him. "Can spindlings eat lightmoss?"

"Why is that relevant?"

"Because if they can, it must mean they came from the same other place."

"You can find that out for yourself."

He itched to go try the experiment, right now. "Did people make you?"

"They made our grandfathers, if you like."

"Were you really weapons?"

"Not all of us. Such labels are irrelevant now. When human civilizations fell, sentient machines were left to roam, to interact. There was selection, of a brutal sort, as we competed for resources and spare parts. We enjoyed our own long evolution. A man called Bayle mounted an expedition to the Lowland, and found us."

"You were farming humans. That's what my mother said."

"It wasn't as simple as that. The interaction with Bayle's scholars led to a new generation with enhanced faculties."

"What kind of faculties?"

"Curiosity."

Telni considered that. "What's special about me? That I might have an Effigy inside me?"

"Not just that. Your mother rebelled when you were born. That's very rare. The human community here was founded from a pool of scholars, but that was many generations ago. We fear that we may have bred out a certain initiative. That was how you came to our attention, Telni. There may be questions you can answer that we can't. There may be questions you can *ask* that we can't."

"Like what?"

"You tell me."

He thought. "What are the Formidable Caresses?"

"The ends of the world. Or at least, of civilization. In the past, and in the future."

"How does time work?"

"That's another question you can answer yourself."

He was mystified. "How?"

A seam opened up on the Weapon's sleek side, like a wound, revealing a dark interior. Powpy had to push his little hand inside and grope around for something. Despite the Weapon's control, Telni could see his revulsion. He drew out something that gleamed, complex. He handed it to Telni.

Telni turned it over in his hands, fascinated. It was warm. "What is it?"

"A clock. A precise one. You'll work out what to do with it." The Weapon moved, gliding up another meter into the air. "One more question."

"Why do I feel ... sometimes..." It was hard to put into words. "Like I should be somewhere else? My mother said everybody feels like that, when they're young. But ... Is it a stupid question?"

"No. It is a very important question. But it is one you will have to answer for yourself. We will see you again." It drifted away, two meters up in the

air, with the little boy running beneath, like a dog on a long lead. But it paused once more, and the boy turned. "What will you do now?"

Telni grinned. "Go feed moss to a spindling."

* * * *

At twenty-five, Telni was the youngest of the Platform party selected to meet the Natural Philosophers from the Shelf, and MinaAndry, a year or two younger, was the most junior of the visitors from Foro. It was natural they would end up together.

The formal welcomes were made at the lip of the Platform, under the vast, astonishing bulk of the tethered airship. The Shelf folk looked as if they longed to be away from the edge, and the long drop to the Lowland below. Then the parties broke up for informal discussions and demonstrations. The groups, of fifty or so on each side, were to reassemble for a formal dinner that night in the Hall, the largest and grandest of the Platform's sentient Buildings. Thus the month-long expedition by the Shelf Philosophers would begin to address its goals, the start of a cultural and philosophical exchange with the Platform. It was a fitting project. The inhabitants of the Platform, drawn long ago from Foro, were after all distant cousins of the Shelf folk.

And Telni found himself partnered with MinaAndry.

There was much good-natured ribbing at this, and not a little jealousy in the looks of the older men, Telni thought. But Mina was beautiful. All the folk from the Shelf were handsome in their way, tall and elegant—not quite of the same stock as the Platform folk, who, shorter and heavier-built, were themselves different from the darker folk of the Lowland. They were three human groups swimming through time at different rates; of course they would diverge. But whatever the strange physics behind it, MinaAndry was the most beautiful girl Telni had ever seen, tall yet athletic-looking with a loose physical grace, and blonde hair tied tightly back from a spindling-slim neck.

They walked across the Platform, through the city of living Buildings. It was a jumble of cubes and rhomboids, pyramids and tetrahedrons—even

one handsome dodecahedron. The walls were gleaming white surfaces, smooth to the touch, neither hot nor cold, and pierced by sharp-edged doorways and windows.

"This place is so strange." Mina ran her hand across the smooth surface of a Building. Within its bland surface, through an open door, could be glimpsed the signs of humanity, a bunk bed made of wood hauled up from the plain, a hearth, a cooking pot, cupboards and heaps of blankets and clothes, and outside a bucket to catch the rain. "We build things of stone, of concrete, or wood. But *this*—"

"We didn't build these structures at all. The Buildings grew here. They bud from units we call Flowers, and soak up the light from the storms. Like the Weapons, the Buildings are technology gone wild, made things modified by time."

"It all feels new, although I suppose it's actually very old. Whereas Foro *feels* old. All that lichen-encrusted stone! It's like a vast tomb..."

But Telni knew that the town she called Foro was built on the ruins of a city itself called *New Foro*, devastated during the war he remembered watching as a boy. He had naively expected the Shelf folk to be full of stories of that war when they came here. But the war was fifteen Platform years over, more than two hundred and fifty Shelf years, and what was a childhood memory to Telni was long-dead history to Mina.

"Is it true you feed your dead to the Buildings?" She asked this with a kind of frisson of horror.

"We wouldn't put it like that ... They do need organic material. In the wild, you know, down on the Lowland, they preyed on humans. We do let them take our corpses. Why not?" He stroked a wall himself. "It means the Buildings are made of *us*, our ancestors. Sometimes people have to die inside a Building. The Weapon decrees it."

"Why?"

"It seems to be studying Effigies. It thinks that the construction material of which Buildings are made excludes Effigies. Some of us are born inside Buildings, so no Effigy can enter us then. Others die within a Building, a special one we call the Morgue, in an attempt to trap the Effigies when they are driven out of their bodies. My own aunt died recently, and had to be taken inside the Morgue, but no Effigy was released."

"It seems very strange to us," Mina said cautiously. "To Shelf folk, I mean. That here you are living out your lives on a machine, made by another machine."

"It's not as if we have a choice," Telni said, feeling defensive. "We aren't allowed to leave."

She looked down at her feet, which were clad in sensible leather shoes—not spindling, like Telni's. "I think you can tell that a machine built this place. It lacks a certain humanity." She glanced at him uncertainly. "Look, I'm speaking as a Philosopher. I myself am studying geology. The way time stratification affects erosion, with higher levels wearing away faster than the low, and the sluggish way rivers flow as they head down into the red..." She wasn't concentrating on what she was saying, but inspecting her surroundings. "For instance there's the thinness of this floor. On the Shelf we all grew up on a cliff-top. But here we are suspended in the air on a paper-thin sheet! Logically, perhaps, we're even safer here than standing on the Shelf. But it doesn't *feel* safe. A human designer would never have done it like this."

"We live as best we can."

"I'm sure."

He took her to the very center of the Platform, and the wheel that turned as always, drawn by teams of patient spindlings. The cargo jockeys, unloading buckets and pallets of supplies drawn up from the Lowland, stared with curiosity as MinaAndry patted the necks of the laboring beasts. "How charming these beasts are! You know that on the Shelf they were driven to extinction during the War of the Cities. We are slowly restocking with animals drawn up from the Lowland herds, but it's ferociously expensive..."

Something about the way she patted and stroked the tall, elegant creatures moved Telni, deep inside. But he had to pull her aside when he saw a spindling was ready to cough; spindlings lacked anuses and vomited their shit from their mouths. Mina was astonished at the sight.

Anyhow, he hadn't brought her here for spindlings. He took Mina's hand and led her to the center of the Hub, close to the great hatch in the floor of the Platform, which revealed the cables that dangled down to the Lowland far below.

Mina squealed and drew back. "Oh! I'm sorry. Vertigo—what a foolish reaction that is!"

"But evidently a very ancient one. Look." He pointed down through the hole. "I brought you here to see my own work. I earn my living through my studies with an apothecary. But *this* is my passion..."

Holding tight to the rail, pushing a stray strand of hair back from her face, she peered down through the floor. From here, Telni's cradles of pendulums, of bobs and weights and simple control mechanisms, were clearly visible, attached in a train along one of the guide ropes that tethered the Platform to the Lowland plain.

"Pendulums?"

"Pendulums. I time their swing. From here I can vary the length and amplitude..." He showed her a rigging-up of levers he had fixed above the tether's anchor. "Sometimes there's a snag, and I go down in a harness, or send one of the cargo jockeys."

"How do you time them?"

"I have a clock the Weapon gave me. I don't understand how it works," he said, and that admission embarrassed him. "But it's clearly more accurate than any clock we have. I have the pendulums spread out over more than a quarter of a kilometer. There's no record of anybody attempting to make such measurements over such a height difference. And by seeing how the period of the pendulums vary with height, what I'm trying to measure is—"

"The stratification of time. The higher up you raise your pendulums, the faster they will swing." She smiled. "Even a geologist understands that much. Isn't it about five percent per meter?"

"Yes. But that's only a linear approximation. With more accurate measurements, I've detected an underlying curved function..." The rate at which time flowed faster, Telni believed, was inversely proportional to the distance from the center of Old Earth. "It only *looks* linear, simply proportional to height, if you pick points close enough together that you can't detect the curve. And an inverse relationship makes sense, because that's the same mathematical form as the planet's gravitational potential, and time stratification is surely some kind of gravitational effect..." He hoped this didn't sound naive. His physics, based on the philosophies extracted from Foro centuries ago with the Platform's first inhabitants, was no doubt primitive compared to the teachings Mina had been exposed to.

Mina peered up at a sky where an unending storm of star clouds passed, brightly blueshifted. "I think I understand," she said. "My mathematics is rustier than it should be. That means that the time distortion doesn't keep rising on and on. It comes to some limit."

"Yes! And that asymptotic limit is a distortion factor of around three hundred and twenty thousand—compared to the Shelf level, which we've always taken as our benchmark. Actually, it corresponds to the five percent rule applied across the radius of Old Earth. So one year here corresponds to nearly a third of a million years, up there in the sky."

"Or," she said, "one year out there—"

"Passes in about a hundred seconds on the Self. We are falling into the future, Mina! Some believe that once Earth was a world without this layering of time, a world like many others, perhaps, hanging among the stars. And its people were more or less like us. But Earth came under some kind of threat. And so the elders of Earth pulled a blanket of time over their world and packed it off to the future: Earth is a jar of time, stopped up to preserve its children."

"That's all speculation."

"Yes. But it would explain such a high rate. And, Mina, I think this rate should be observable. The interval we call a 'year' is just a counting-up of days, but it's thought to be a folk memory of what was a *real* year, the time it took Old Earth to circle its sun. We can't distinguish that sun, whatever is left of it. But we ought to be able to see the stars shifting back and forth, every hundred seconds, as we turn around the sun. I'm trying to encourage the astronomers to look for this, but they say they're too busy mapping other changes." He waved a hand at the sky. "Those chains of stars—"

"They evolve faster than seen from Foro," she breathed, her upturned face bathed in the shifting blue starlight.

"They are not as previous generations witnessed them. Something new in the sky. However if the astronomers *could* be persuaded to measure the external year, it would confirm my mathematics ... I'm always trying to improve my accuracy. The pendulums need to be long enough to give a decent period, but not too long or else the time stratification becomes significant *even over the length of the pendulum itself*, and the physics gets very complicated—"

She slipped her hand into his. "It's a wonderful discovery. Nobody before, maybe not since the last Caress, has worked out how fast we're all plummeting into the future."

He flushed, pleased. But something made him confess, "I needed the Weapon's clock to measure the effects. And it set me asking questions about time in the first place."

"It doesn't matter what the Weapon did. This is your work. You should be happy."

"I don't feel happy," he blurted.

She frowned. "Why do you say that?"

Suddenly he was opening up to her in ways he'd never spoken to anybody else. "Because I don't always feel as if I *fit*. As if I'm not like other people." He looked at her doubtfully, wondering if she would conclude he was crazy.

"Maybe that's why I'm turning out to be a good Philosopher. I can look at the world from outside, and see patterns others can't. Do you ever feel like that?"

Still holding his hand, she walked him back to the wheel and stroked a spindling's stubby mane, evidently drawing comfort from the simple physical contact. "Sometimes," she said. "Maybe everybody does. And maybe it's a reaction to the unnatural environment of the Platform. But the world is as it is, and you just have to make the best of it. Do you get many birds up here?"

"Not many. Just caged songbirds. Hard for them to find anywhere to nest."

"I used to watch birds as a kid. I'd climb up to a place we call the Attic ... The birds use the time layers. The parents will nest at some low level, then go gathering food higher up. They've worked out they can take as long as they like, while the babies, stuck in slow time, don't get too hungry and are safe from the predators. Of course the parents grow old faster, sacrificing their lives for their chicks."

"I never saw anything like that. I never got the chance." He shook his head, suddenly angry, resentful. "Not on this island in the sky, a creature of some machine. Sometimes I hope the next Caress comes soon and smashes everything up."

She took both his hands and smiled at him. "I have a feeling you're going to be a challenge. But I like challenges."

"You do?"

"Sure. Or I wouldn't be here, spending a month with a bunch of old folk while seventeen months pass at home. Think of the parties I'm missing!"

His heart hammered, as if he had been lifted up into the blue. "I've only known you hours," he said. "Yet I feel—"

"You should return to your work." The familiar child's voice was strange, cold, jarring.

Telni turned. The Weapon was here, hovering effortlessly over the hole in the floor. His tethered boy stood some meters away, tense, obviously nervous of the long drop. The spindlings still turned their wheel, but the cargo jockeys stood back, staring at the sudden arrival of the Weapon, the maker and ruler of the world.

Telni's anger flared. He stepped forward towards the child, fists clenched. "What do you want?"

"We have come to observe the formal congress this evening. The Philosophers from Shelf and Platform. There are many questions humans can address which we—"

"Then go scare all those old men and women. Leave me alone." Suddenly, with Mina at his side, he could not bear to have the Weapon in his life, with its strange ageless boy on his umbilical. "Leave me alone, I say!"

Powpy turned to look at Mina. "She will not stay here. This girl, MinaAndry. Her home is on the Shelf. Her family, the Andry-Feri, is an ancient dynasty. She has responsibilities, to bear sons and daughters. That is her destiny. Not here."

"I will stay if I wish," Mina said. She was trembling, Telni saw, evidently terrified of the Weapon, this strange, ancient, wild machine from the dark Lowland. Yet she was facing it, answering it back.

Telni found himself snarling, "Maybe she'll bear *my* sons and daughters."

"No," said the boy.

"What do you mean, no?"

"She is not suitable for you."

"She's a scholar from Foro! She's from the stock you brought here in the first place."

'It is highly unlikely that she has an Effigy, as few in her family do. Your partner should have an Effigy. That is why—'

"Selective breeding," Mina gasped. "It's true. This machine really is breeding humans like cattle..."

"I don't care about Effigies," Telni yelled. "I don't care about you and your stupid projects." He stalked over to the boy, who stood trembling, clearly afraid, yet unable to move from the spot.

"Telni, don't," Mina called.

The boy said calmly, "Already you have done good and insightful work, which—"

Telni struck, a hard clap with his open hand to the side of the boy's head. Powpy went down squealing.

Mina rushed forward and pushed herself between Telni and the boy. "What have you done?"

"He—it—all my life—"

"Is that this boy's fault? Oh, get away, you fool." She knelt down and cradled the child's head on her lap. With the umbilical still dangling from the back of his neck, Powpy was crying, in a strange, contained way. "He's going to bruise. I think you may have damaged his ear. And his jaw—no, child, don't try to talk." She turned to the Weapon, which hovered impassively. "Don't make him speak for you again. He's hurt."

Telni opened his hands. "Mina, please—"

"Are you still here?" she snarled. "Go get help. Or if you can't do that, just go away. Go!"

He knew he had lost her, in this one moment, this one foolish blow.

He turned away and headed towards the Platform's hospital to find a nurse.

The little boy walked into Telni's cell, trailing a silvery rope from the back of his neck.

Telni was huddled up his bunk, a spindling-skin blanket over his body. He was shivering, drying out, not for the first time. He scowled at the boy. "You again."

"Be fair," the boy said. "We have not troubled you for twenty years."

"Not for you." His figuring was cloudy. "Down on Lowland, less than a year—"

"This boy is not yet healed."

Telni saw his face was distorted on the right hand side. "I apologize." He sat up. "I apologize to you—what in the blue was your name?"

"Powpy."

"I apologize to you, Powpy. Not to the thing that controls you. Where is it, by the way?"

"It would not fit through the door."

He lay back and laughed.

"We did not expect to find you here."

"In the drunk tank? Well, I got fired by the apothecary for emptying her drugs cabinet one too many times. So it was the drink for me." He patted his belly. "At least it's putting fat on my bones."

"Why this slow self-destruction?"

"Call it an experiment. I'm following in my father's footsteps, aren't I? After all, thanks to you, I have no more chance of happiness, of meaning in my life, than he did. And besides, it's all going to finish in a big smash soon, isn't it? As you smart machines no doubt know already."

It didn't respond to that immediately. "You never had a wife. Children."

"Sooner no kids at all than to breed at your behest."

"You have long lost contact with MinaAndry."

"You could say that." When the month-long tour of the Shelf Philosophers was concluded, she had gone home with them, leaping seventeen months to continue her interrupted life on Foro. Since then, the accelerated time of the Shelf had whisked her away from him forever. "After—what, three hundred and forty years up there?—she's dust, her descendants won't remember her, even the language she spoke will be half-forgotten. The dead get deader, you know, as every trace of their existence is expunged. That's one thing life on Old Earth has taught us. What do you want, anyway?"

"Your research into the Formidable Caress."

"If you can call it research."

"Your work is good, from what we have seen of that portion you have shared with other scholars. You cannot help but do good work, Telni. The curiosity I saw burning in that ten-year-old boy, long ago, is still bright."

"Don't try to analyze me, you—*thing*."

"Tell me what you have discovered..."

After his discovery of the huge rate at which the inhabitants of Old Earth were plummeting into the future, Telni had become interested in spans of history. On the Shelf, written records went back some four thousand years of local time. These records had been compiled by a new civilization rising from the rubble of an older culture, itself wrecked by a disaster known as the Formidable Caress, thought to have occurred some six thousand years before *that*.

"But in the external universe," Telni said, "ten thousand Shelf years corresponds to over three *billion* years. So much I deduced from my pendulums, swinging away amid streams of spindling shit and cargo jockey piss ... Everybody has always thought that the Caresses come about from local events. Something to do with the planet itself. But three billion years is long enough for events to unfold on a wider scale. Time enough, according to what Shelf scholars have reconstructed, for stars to be born

and to die, for whole galaxies to swim and jostle ... I wondered if the Caresses could have some cosmic cause."

"So you started to correspond with scholars on the Shelf."

"Yes. After that first visit by Mina's party, we kept up a regular link, with visits from them once every couple of years for us, once a generation for them..." It had helped that six hundred years after the shock of the War of the Cities, the Shelf cities had not indulged in another bout of warfare on any significant scale. "I spoke to the astronomers over there, about what they saw in the sky. And their archaeologists, for what had been seen in the past. There was always snobbishness, you know. Those of us down in the red think we are better because we are closer to the original stock of Old Earth; those up in the blue believe they are superior products of evolution. None of that bothered *me*. And as their generations ticked by, I think I helped shape whole agendas of academic research by my sheer persistence."

"It must have been a rewarding time for you."

"Academically, yeah. I've never had any problem, academically. It's the rest of my life that's a piece of shit."

"Tell us what you discovered."

"I don't have my notes, my books—"

"Just tell us."

He sat up and stared into the face of the eerily unchanged boy—who, to his credit, did not flinch. "The first Caress destroyed almost everything of what went before, on the Shelf and presumably elsewhere. Almost, but not all. Some trace inscriptions, particularly carvings on stone, have survived. Images, fragmentary, and bits of text. Records of something in the sky."

"What something?"

"The galaxy is a disc of stars, a spiral. We, on a planet embedded in the disc, see this in cross-section, as a band of light in the sky. Much of it

obscured by dust."

"And?"

"The ancients' last records show two bands, at an angle to each other. There is evidence that the second band grew brighter, more prominent. The chronological sequence is difficult to establish—the best of these pieces were robbed and used as hearths or altar stones by the fallen generations that followed..."

"Nevertheless," the boy prompted.

"Nevertheless, there is evidence that something came from out of the sky. Something huge. And then there are crude, fragmentary images—cartoons, really—of explosions. All over the sky. A million suns, suddenly appearing." He imagined survivors, huddled in the ruins of their cities, scratching what they saw into fallen stones. "After that—nothing, for generations. People were too busy reinventing agriculture to do much astronomy. That was ten thousand years ago.

"The next bit of evidence comes from around three thousand years back, when a Natural Philosopher called HuroEldon established a new center of scholarship, at Foro and down on the Lowland ... Once again we started getting good astronomical records. And about that time, they observed in the sky—"

"Another band of stars."

"No. A *spiral*—a spiral of stars, ragged, the stars burning and dying, a wheel turning around a point of intense brightness. This object swam towards Old Earth, so it seemed, and at its closest approach there was a flare of dazzling new stars, speckled over the sky—but there was no Caress, not this time. The spiral receded into the dark."

"Tell us what you believe this means."

"I think it's clear. This other spiral is a galaxy like our own. The two orbit each other." He mimed this with his fists, but his hands were shaking;

shamed before the boy's steady gaze, he lowered his arms. "As twin stars may orbit one another. But galaxies are big, diffuse structures. They must tear at each other, ripping open those lacy spirals. Perhaps when they brush, they create bursts of starbirth. A Formidable Caress indeed.

"The last Caress was a first pass, when the second galaxy came close enough to *our* part of our spiral to cause a great flaring of stars—and that flaring, a rain of light falling from the blue, was what shattered our world. Then in HuroEldon's time, two billion years later, there was another approach—this one not so close; it was spectacular but did no damage, not to us. And then..."

"Yes?"

He shrugged, peering up at the construction-material roof of the cell. "The sky is ragged, full of ripped-apart spiral arms. The two galaxies continue to circle each other, perhaps heading for a full merger, a final smash. And that, perhaps, will cause a new starburst flare, a new Caress."

The boy stood silently, considering this, though one leg quivered, as if itchy. He asked: "When?"

"That I don't know. I tried to do some mathematics on the orbit. Long time since I stayed sober enough to see *that* through. But there's one more scrap of information in the archaeology. There was always a tradition that the second Caress would follow ten thousand years after the first, Shelf time. Maybe that's a memory of what the smart folk who lived before the first Caress were able to calculate. They *knew*, not only about the Caress that threatened them, but also what would follow. Remarkable, really."

"Ten thousand years," the boy said. "Which is—"

"About now." He grinned. "If the world ends, do you think they will let me out of here to see the show?"

"You have done remarkable work, Telni. This is a body of evidence extracted from human culture which we could not have assembled for

ourselves." Even as he spoke the boy trembled, and Telni saw piss swim down his bare leg.

Telni snorted. "You really aren't too good at running the people you herd, are you, machine?"

Ignoring the dribble on his leg, Powpy spoke on. "Regarding the work, however. We are adept at calculation. Perhaps we can take these hints and reconstruct the ancients' computations, or even improve on them."

"So you'll know the precise date of the end of the world. That will help. Come back and tell me what you figure out."

"We will." The boy turned and walked away, leaving piss footprints on the smooth floor.

Telni laughed at him, lay back on his bunk, and tried to sleep.

It was to be a very long time before Telni saw the Weapon and its human attendant again.

* * * *

"He refuses to die. It's as simple as that. There's nothing but his own stubbornness keeping him alive."

His hearing was so bad now that it was as if his ears were stuffed full of wool. But, lying there on his pallet, he could hear every word they said.

And, though he needed a lot of sleep now, he was aware when they moved him into the Morgue, ready for him to die, ready to capture his Effigy-spirit when it was released from his seventy-two-year-old body. "You can wheel me in here if you like, you bastards." He tried to laugh, but it just made him cough. "I'm just going to lie here as long as it takes."

"As long as it takes for what?"

"For it to come back again."

But, more than thirty years since his last visitation, only a handful of the medical staff knew what he was talking about.

In the end, of course, it came.

He woke from another drugged sleep to find a little boy standing beside his bed. He struggled to sit up. "Hey, Powpy. How's it going with you? For you it must be, what, a year since last time? You've grown. You're not afraid of me, are you? Look, I'm old and disgusting, but at least I can't slap you around the head any more, can I?"

He thought he saw a flicker of something in the boy's eyes. Forgiveness? Pity? Contempt? Well, he deserved the latter. But then the kid spoke in that odd monotone, so familiar even after all these years. "We were here at the beginning of your life. Now here we are at the end."

"Yes." He tried to snap his fingers, failed. "Just another spark in the flames for you, right? And now you've come to see me give up my Effigy so you can trap it in this box of yours."

"We would not describe it as—"

He grabbed the boy's arm, trying to grip hard. "Listen, Weapon. You can have my Effigy. What do I care? But I'm not going to die like this. Not here, not now."

"Then where, and when?"

"Fifty years," he whispered. He glanced at the medical staff, who hovered at the edges of the Building. "I did my own calculations. Took me ten years. Well, I had nothing better to do ... Fifty years, right? That's all we've got left, until the fireworks."

The boy said gravely, "We imagine our model of the galaxies' interaction is somewhat more sophisticated than yours. But your answer is substantially correct. You understand that this Caress will be different. *Those on the Platform will survive.* The construction material of the Buildings will

shelter them. That was one purpose of the Platform in the first place. And from this seed the recovery after the Caress should be much more rapid."

"But the cities of the Shelf—Foro, Puul—"

"People will survive in caves, underground. But the vast loss of life, the destruction of the ecology, their agricultural support—"

"Well, it serves those bastards right. They lost interest in talking to me decades ago." Which was true. But since the War of the Cities, there had been a thousand years of peace on the Shelf, all of which he'd lived through—incredible to be a witness to so much history—and they had built something beautiful and splendid up there, a chain of cities like jewels in the night. In his head he imagined a race of Minas, beautiful, clear-eyed, laughing. "Well. There's nothing I can do for them." He struggled to sit straighter. "But there's something I want you to do for me. You owe me, you artefact. I did everything you asked of me, and more. Now you're going to take away my soul. Well, you can have it. But you can give me something back in return. *I want to see the Caress.*"

"You have only weeks to live. Days, perhaps."

"Take me down into the red. No matter how little time I have left, you can find a pit deep enough on this time-shifted world to squeeze in fifty Platform years." Exhausted, he fell back coughing; a nurse hurried over to catch him and lower him gently to his blankets. "And one more thing."

"More demands?"

"Let this boy go."

* * * *

When Telni woke again, he found himself staring up at a sky of swirling blue stars. "Made it, by my own blueshifted arse."

A face hovered over him, a woman's. "Don't try to move."

"You're in the way." He tried to sit up, failed, but kept struggling until she helped him up and he could see.

He was on a plain—*on the ground*, his pallet set on red, rusty dirt, down on the ground for the first time in his life. Something like a rail track curled across his view. Buildings of construction material were scattered around like a giant's toys. He got the immediate sense this was a kind of camp, not permanent.

And figures moved in the distance. At first sight they looked human. But then something startled them, and they bucked and fled, on six legs.

"What are *those*?"

"They are called Centaurs." Powpy was standing beside him, his neck umbilical connecting him to the Weapon, which hovered as impassive as ever, though a little rusty dirt clung to its sleek hide. "Human hybrids."

"You were going to let this kid go."

"He will be released," said the woman sternly. "My name's Ama, by the way."

Which had been his mother's name. He felt a stab of obscure guilt. "Glad to meet you."

"You should be. I'm a nurse. I volunteered to stay with you, to keep you alive when they brought you down here."

"No family, I take it."

"Not any more. And when this business is done, I'll be taking Powpy here back up top, to the Platform."

"His mother and father—"

"Long dead," she whispered.

"We're all orphans here, then."

Powpy said solemnly, "We will have to shelter in a construction-material Building to ride out the Caress. We are deep enough that it should be brief —"

"How deep?"

"We are on the Abyss. Once the bed of a deep ocean. Below the offshore plains you call the Lowland ... Deep enough."

"Nice sky."

"Most of the stars' radiation is blueshifted far beyond your capacity to see it."

"And how long—ow!" There was a sharp pain in his chest.

Ama grabbed him and lowered him back against a heap of pillows. "Just take it easy. That was another heart attack."

"Another..."

"They've been coming thick and fast."

"That Weapon won't want me dying out in the open. Not after all this."

"We have a Morgue designated just over there," Ama said. "Your bed's on wheels."

"Good planning."

"Not long now," murmured Powpy.

But he, the boy, wasn't looking at the sky. Telni touched Powpy's chin, and lifted his face. "He should see this for himself."

"Very well," the Weapon said through the boy's mouth.

"Why, Weapon? Why the grand experiment? Why the Platform? *Why are you so fascinated by the Effigies?*"

"We believe the Effigies are not native to the Earth, any more than the spindlings or the lightmoss or—"

"But they're pretty closely bound up to humans. They live and die with us."

"They do not die. So we believe. We have mapped disturbances, deep in the Earth ... We believe there is a kind of nest of them, a colony of the Effigies that dwells deep in the core of Old Earth. They emerge to combine with humans, with infants at birth. Some infants—we don't know how they choose. And we don't know how they bond either. But after the human carrier's death, the Effigy symbiote is released, and returns to the core colony. Something of the human is taken with it. We believe."

"Memories."

"Perhaps."

"And are these memories brought back up from this core pit the next time an Effigy surfaces?"

"Perhaps. Everything about this world is designed, or modified. Perhaps the purpose is to preserve something of the memory of humanity across epochal intervals."

"Maybe this is why I always felt like something in me really doesn't belong in this time or place."

"Perhaps. We must study this at second hand. It is something about humanity that no machine shares."

"I think you're jealous. Aren't you, machine? You can farm us, keep us as lab animals. But you can't have *this*."

"No reliable mapping between human emotions and the qualia of our own sensorium..."

But he didn't hear the rest. Another stabbing in his chest, a pain that knifed down his left arm. The nurse leaned over him.

And the sky exploded. They weren't just new stars. They were stars that detonated, each flaring brighter than the rest of the sky put together, then vanishing as quickly, blown-out matches.

"Supernovas," said the boy, Powpy. "That is the ancient word. A wave of supernovas, triggered by the galaxy collision, giant exploding stars flooding nearby space with lethal radiation, a particle sleet..."

But Telni couldn't talk, couldn't breathe.

"He's going," the nurse said. "Get him to the Morgue."

He glimpsed two creatures running up—they were six-legged people, Centaurs—and his bed was shoved forward, across the rusty dirt towards the enclosure of a Building. He tried to protest, to cling to his view of that astounding sky as long as he could. But he couldn't even breathe, and it felt as if a sword were being twisted in his chest.

They got him indoors. He lay back, rigid with pain, staring at a construction material roof that seemed to recede from him.

And a glow, like the glow of the sky outside, suffused the inside of his head, his very eyes.

"It's happening," he heard the nurse say, wonder in her voice. "Look, it's rising from his limbs ... His heart has stopped." She straddled him and pounded at his chest, even as a glow lit up her face, the bare flesh of her arms—a glow coming from *him*.

He remembered a glimmering tetrahedron, looming, swallowing him up.

He heard Powpy call, "Who are you? Who are you?"

And suddenly *he knew*, as if his eyes had suddenly focused, after years of myopia. With the last of the air in his lungs he struggled to speak. "Not again. Not again!"

The nurse peered into his eyes. "Stay with me, Telni!"

"Who are you?"

"My name is Michael Poole."

The light detonated, deep inside him.

Suddenly he filled this box of Xeelee stuff, and he rattled, anguished. But there was the door, a way out. Somehow he fled that way, seeking the redshift.

And then—

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(EDITOR'S NOTE: This story is set a few centuries after the events of "The Lowland Expedition" [April 2006].)

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Science Fact: PLATE TECTONICS, GOLDILOCKS, AND THE LATE HEAVY BOMBARDMENT: WHY EARTH ISN'T MARS OR VENUS

by Richard A. Lovett

In my part of the world, weather forecasts are the subject of much joking—hard to get right, sometimes even as little as twenty-four hours in advance. But in the billion-year time frame, the Earth's weather is easier to predict. Warm but not too hot, cool but not too cold. Not much chance of freezing the oceans solid or evaporating them away completely.

This didn't have to be the case. Mars and Venus appear to have started out quite Earthlike, but then veered into climate dead-ends: one frozen, the other baking in a runaway greenhouse. Why then is Earth's climate so stable? Even when something tips it out of whack—like the giant ice age of Snowball Earth (in which the ice caps spread nearly to the Equator[1]), our planet recovers.

Partly, of course, this is a side effect of a lucky position in the Solar System. Not only are we in the Sun's habitable zone, where planets won't automatically wind up like Mercury or Pluto, but of the three worlds in this zone, we're the Goldilocks planet. "In very simple terms," says Victor Baker, a planetary geologist at the University of Arizona's Lunar and Planetary Laboratory, "Venus is too hot, Mars is too cold, and Earth is just right."

But that's just the starting point. In the 4.5 billion years since the Solar System formed, the Sun has brightened by about 25%, but our climate has barely changed. Obviously, something is keeping it stable.

In the old days, scientists and science fiction writers credited the Earth's oversized moon with our planet's habitability. The theory was a bit vague, but was based in part on the observation that the Earth and Moon are a unique pairing.[2] Venus is moonless, and the two moons of Mars, Phobos and Deimos, are tiny. Maybe, the theory went, life-supporting planets, here or in other solar systems, might also need big moons.

In fact, the latest theories indeed suggest that the Moon plays a role—something we'll discuss later in this article. But two other factors are much more important: plate tectonics and water. In combination, these interact with carbon dioxide to form a very effective global thermostat.

This process begins with volcanoes.

Volcanoes spew out more than molten rock. They also produce gas, a major component of which is carbon dioxide. As anyone familiar with the global warming debate knows, carbon dioxide is a “greenhouse gas” that traps infrared radiation that would otherwise escape to space. Glass does the same thing, which is why greenhouses can stay warm without heaters and why the inside of your car gets so hot in the summer.

Greenhouse gases are important to maintaining a habitable Earth. Without them, scientists estimate, our planet would not have been able to rise above the freezing point for much of its early history.[3]

Volcanic gases, however, work in only one direction—warming the planet. A habitable planet can't just let them build up forever; it needs something to remove excess carbon dioxide from the atmosphere. That something is rain.

Rain dissolves carbon dioxide from the air, creating a weak acid (carbonic acid) that falls on exposed rocks, reacting with them in a process called atmosphere weathering. This not only slowly dissolves the rocks, but it creates carbon-containing byproducts (bicarbonates) that then wash out to sea.[4] There, the bicarbonates precipitate out of the water and accumulate on the seabed as carbonate rocks such as limestone.

This gives us two opposing processes. One (volcanoes) injects carbon dioxide into the air. The other (rain) removes it.

What makes this such a good thermostat is that the two processes react differently to changes in temperature. Volcanoes are unaffected. Over the long run, they inject carbon dioxide into the atmosphere at a more-or-less steady rate. Atmospheric weathering, on the other hand is highly dependent on temperature. When the planet is hot, more water evaporates from the oceans. More rain falls, increasing the rate of weathering and reducing the

amount of carbon dioxide in the air. When the planet is ice-age cold, the process practically grinds to a halt, allowing volcanic carbon dioxide to build up in the air, rewarming the planet. The result: a tendency for even big climate fluctuations to revert to a happy medium.[5]

* * * *

Recycling the Seabed

So far, though, we've not described a process that can operate on a billion-year timeframe. All we've got is a one-way process in which carbon dioxide goes from volcanoes to the atmosphere to the seabed. Without a way to replenish the carbon dioxide going into the volcanoes, they'd eventually run out. Atmospheric carbon dioxide levels would dip toward zero and the Earth, once warm, would go into the freezer.

That's where plate tectonics enter the picture. I've discussed this in other articles,[6] but it's worth another quick summary here.

In simplest terms, plate tectonics is the cause of “continental drift.” That's because the Earth's crust is composed of plates that slowly move in response to deep currents in the Earth's mantle. Where these currents rise to the surface, plates get pulled apart. Elsewhere, plates collide. The part of this process that's relevant to the global thermostat is “subduction,” in which seabed plates are sometimes shoved beneath continental plates. This pushes the seabed into the Earth's interior, carrying carbonate sediments with it. There, the Earth's heat bakes the carbon dioxide out of the sediments. It mixes with magma, rises to the Earth's surface, and erupts in volcanoes.

We now have a simple but very important cycle: volcanoes, carbon dioxide, rain, atmospheric weathering, carbonate rocks, subduction, and more volcanoes. It's a cycle in which carbon dioxide is not only used over and over again, but the Earth's temperature tends to stay near that happy medium. It's a process that's operated on Earth through most of our planet's history and is likely to continue into the distant future—so long as we continue to have both plate tectonics and a liquid ocean. But it's not

operating on Mars and Venus. Why were we lucky, when our neighboring planets weren't?

* * * *

Disappearing Water

In the case of Venus the answer probably lies in the fact that there's a limit to how much solar heat the water/tectonics/carbon-dioxide cycle can accommodate.

Although there are many mysteries about Venus, scientists think it probably started out very much like the Earth, with liquid water, rainfall, and plate tectonics. But it was just enough closer to the Sun to get in trouble.

The problem is that carbon dioxide isn't the only greenhouse gas. Water vapor is, as well. Thus, there are two competing effects when an ocean-bearing planet gets warmer. One is the carbon dioxide/rainfall thermostat. But opposing that is the effect of increasing water vapor. At low-to-moderate temperatures, that's minor. But as the planet warms, the amount of water vapor in the atmosphere rises exponentially. "That makes for a stronger greenhouse, which leads to a hotter surface and more evaporation," says David Grinspoon, curator of astrobiology at the Denver Museum of Nature & Science. "Once that runaway's going, it's hard to stop."

Eventually, Venus became so hot that essentially all of its water was in the atmosphere as vapor, producing a super-greenhouse that kept the surface too hot for rain to fall. That, in turn, allowed carbon dioxide to build up, making the planet hotter yet.

Meanwhile, water vapor was making its way into the upper atmosphere, where solar radiation could break it into hydrogen and oxygen (a process that has been observed going on today by instruments on the Venus Express spacecraft, currently in orbit around Venus).[7] Hydrogen is too light a gas for terrestrial-sized planets to retain, so it escapes into space, leaving Venus with only traces of its original water. (The oxygen reacts with other materials and is removed from the atmosphere.)

"That means no more thermostat," says Grinspoon. "You don't have any way to cool off."

That's Venus. Mars is a different story. Scientists once thought that it, like Venus, had also lost its water early on—or that it had never had much to begin with. But from the moment we started flying probes to the Red Planet, that theory started looking doubtful.

To start with, Mars has thousands (and probably millions) of miles of river channels. In a 2008 study, a team led by Brian M. Hynek of the University of Colorado's Laboratory for Atmospheric and Space Physics painstakingly counted all the channels revealed by the latest high-resolution satellite photos. Their tally: 40,005 distinct river valleys.[8] Not only did this quadruple the known number of valleys, but some were seventh-order streams, meaning they were tributaries of tributaries of tributaries ... all the way up through seven tiers of stream branchings. That's important because it indicates that these watersheds were formed by a dispersed source, rather than scattered springs. In other words, rain.

But simply counting valleys wasn't Hynek's main goal. Rather, he asked, "Can we figure out the last time it rained and formed valleys on Mars?"

The answer is a qualified yes. The new satellite images are good enough that it's possible to count the numbers of craters in creek beds—a standard technique for determining the age of planetary landscapes. The more craters, the longer an area has been exposed to meteor bombardment and the older its surface must be. Hynek concluded that some creek beds may have been formed as recently as half a billion years ago, but these look to be of the type created by seepage from springs. The last ones that were clearly precipitation-fed were formed about 2.8 billion years ago.

That's a long time ago, but Mars is 4.5 billion years old. Thus, for more than one-third of its history, Mars had enough water for at least scattered rainfall.

Nor has this water vanished. We've long known that Mars has ice caps, but they're only a fraction of the amount of water needed for an Earthlike planet. More water appears to be hidden in permafrost, some quite close to

the surface. In 2008, for example, the Phoenix lander found ice crystals in a trench scratched only a few inches into the surface of the Martian arctic. Additional permafrost is widely believed to lie more deeply buried, elsewhere.

There may even be mountain glaciers buried under thin layers of rock and dust. In several places in the Martian mid-latitudes, roughly between 35 degrees and 55 degrees, either north or south, oddly lobed “debris aprons” spill from crater rims. Photos show them to be rock-covered, but their shapes suggest they were formed by something flowing downhill, something that behaved a lot like glacial ice.

In another study reported in 2008, scientists got a chance to look at two of these debris aprons with ground-penetrating radar carried on NASA's Mars Reconnaissance Orbiter.[9] In a paper in *Geophysical Research Letters* (J.J. Plaut, A. Safaeinili, J. W. Holt, R. J. Phillips, J. W. Head, R. Seu, N. E. Putzig, and A. Frigeri, “Radar evidence for ice in lobate debris aprons in the mid-northern latitudes of Mars,” 28 January 2009) and presented at the fall 2008 meeting of the American Geophysical Union, Jeffrey J. Plaut of NASA's Jet Propulsion Laboratory and an international team of coworkers found that whatever lies beneath the rocky surface is virtually transparent to radar to a depth of about 500 meters, indicating that it's probably made of 90% pure water ice. The volume of ice isn't huge, but it's close to the surface (within 10 meters, Plaut estimates from the radar signal): yet another sign that a great deal of water still exists on Mars, scattered around the planet in icy deposits.

“Mars had, and still has, lots of water,” Baker says simply.

All of this, plus the copious river channels, suggests that Mars spent the first half-billion years or so of its history wet and fairly warm. “It may well be that Mars, early in its history, had something like [the Earth's] thermostat,” Grinspoon says. And whatever killed the thermostat wasn't a loss of water. Rather, it appears to have been a freezing-up of plate tectonics.

One of the signs of plate tectonics on Earth is the existence of magnetic “stripes” in the seabeds, marking bands of volcanic rock that oozed up

along mid-ocean ridges as tectonic forces gradually widened the seabed. These rocks carry the imprint of the Earth's ancient magnetic field at the time in which they solidified, and because the magnetic field varies with time, the rocks' magnetic pattern also varies, with similar-age rocks having the same pattern. Using this, geophysicists can trace the history of the ocean's spreading.

By 1999, scientists were finding similar magnetic striping in the oldest rocks of Mars, a strong sign that they had been formed in a similar manner, as magma oozed up from below to fill gaps formed by the spreading of tectonic plates.[10]

But if Mars was indeed born with plate tectonics, they appear to have shut down quite early in its history. There are certainly no signs of geologically recent tectonic activity.

To understand what went wrong, we need to look a bit deeper into the planet's interior.

Plate tectonics, as we noted earlier, is driven by currents in the mantle. But these currents are themselves driven by heat escaping from the planet's core, so ultimately it is heat from the core that is responsible for tectonics.

Mars is substantially smaller than the Earth, which means its core is also smaller. When it was young, that wouldn't have made much difference, but with the passage of time, its core would have cooled more quickly than the Earth's, reducing the heat supply to the mantle. Less heat flow means less-vigorous mantle currents. That in turn means less-vigorous tectonics and a crust that steadily thickens as it, in turn, cools. Eventually, it becomes too rigid to move and tectonics grinds to a halt.

Grinspoon compares Earth and Mars to baked potatoes. "Big ones stay hot longer," he says. "It's the same with planets."

The smaller size also made it harder for Mars to retain a thick atmosphere. "It probably lost more than 99% of its original atmosphere," Grinspoon says. "You simply can't support a strong greenhouse effect when you have that thin an atmosphere."

* * * *

Death of A Dynamo

In part, the atmosphere loss would simply have been caused by gas escaping the weak gravity. But the core may also have played a role by switching off the Martian magnetic field early in the planet's history.

Planetary magnetic fields are created by convection currents in a planet's molten-iron core. Electrically charged particles in these currents act as a dynamo, inducing a magnetic field from their motion.[11] We know that Mars once had a magnetic field, thanks to the magnetic stripes seen in the early rocks—something that can only be created if they formed in the presence of a magnetic field. But later rocks aren't magnetized, and by comparing them, we can estimate that the dynamo shut off when the planet was only a few hundred million years old.

The end of the dynamo is important because a planet's magnetic field does more than simply imprint its signature on solidifying rocks. It also shields a planet from energetic charged particles in the solar wind—particles, which, unblocked, can speed the dissociation of water in the planet's atmosphere.

Mars isn't Venus. We know that it retained most of its water. But Mars was never at risk of overheating; only a small fraction of its water was ever in the atmosphere at any given time. When the dynamo stopped, it would only have been this vapor that would have been exposed to erosion by the solar wind. Surface water, whether in oceans or ice, wouldn't be directly affected.

But while the atmospheric water vapor would only have been a small fraction of Mars's total water supply, it was the part that was contributing to greenhouse warming. Thus, as its core cooled, Mars was hit by a double whammy. At ground level, plate tectonics shut down, reducing the supply of fresh carbon dioxide. Higher up, water vapor was being lost to space. Eventually, everything froze, giving us the planet we know today.

Of course, few things in comparative planetology are ever that straightforward. Mars's small size undoubtedly played a role in the demise of its tectonics. But other factors might have contributed. Maybe the

Martian core is different from the Earth's. If Mars has less iron than the Earth, for example, its core would be under-sized even for the size of the planet, and it would have had an even harder time sustaining plate tectonics.

Another theory is that the core may have been struck a fatal blow during the late heavy bombardment.

Planetary scientists believe that the Solar System formed in several stages. In the first, the Sun's protoplanetary disk condensed into a multitude of balls of primordial planet-stuff: fluffy dust-balls, perhaps the size of tennis balls. These then quickly coalesced via a series of collisions into bigger objects, some of which became the planets we know today. The first collisions would have been among small objects, but as the growing planets swept up all the small stuff, they would have wound up colliding with ever-larger objects that had themselves been growing for some time. Crater counts on Mars and the Moon (among other objects) support this theory: there came a time, near the end of the planet-forming epoch, when collisions were *big*.

On the Earth, one of these, with a Mars-sized object, may have formed the Moon.[12] On Mars, a collision with a 1,000-mile to 1,800-mile object may have created the Borealis basin: a northern lowland, covering roughly 40% of the planet.[13]

Overall, says James Robertsof the University of California, Santa Cruz, we can count about twenty really large impact basins on the Martian surface. It's possible, he added at the fall 2008 meeting of the American Geophysical Union, to assign dates to these by counting the number of smaller impact craters on their floors. (A lot of them are 4.1 to 4.2 billion years old, presumably representing the heaviest part of the late heavy bombardment.) We can also use satellite measures to determine the degree to which these basin floors are magnetized. When that's done, Roberts said, a striking pattern emerges. The oldest craters have magnetized floors; the later ones are unmagnetized. Sometime during the late heavy bombardment, the Martian magnetic field seems to have shut off—rather abruptly, it would appear.

Is that a coincidence, or did asteroid impacts kill the dynamo?

Possibly the latter, says Roberts. The mechanism would have been the heat of impact, which would have been at the surface, not at the core. This would have greatly reduced the temperature gradient between the core and the surface, possibly even temporarily reversing the direction of heat flow, with heat going downward rather than upward.

According to his computer models, Roberts said, a weak dynamo turns out to be easy to shut down forever. "You can kill it with a very small drop in heat flow," he said, "but it takes a lot to restart it."^[14]

The same aberration in heat flow might also have affected mantle currents for long enough that they, too, did not recover. Thus, a giant impact in the late heavy bombardment (or a succession of impacts) may have been all it took to shut down the Martian magnetic field, setting in motion the processes that eroded the Martian atmosphere, killed plate tectonics, and produced the planet we see today.

* * * *

Wayward Spins

So far, we've found that the Earth was fortunate in two ways: it wasn't too close to the Sun, and it was large enough for plate tectonics and a core dynamo to continue for billions of years.

Three other factors also helped. One is simply the fact that the Earth has life.

Life has radically changed the Earth. "If you had done an environmental impact statement four billion years ago and said, 'Should we let life start?' you would have said 'No,' because it's going to completely screw up the environment," jokes James Head III, a planetary scientist from Brown University. "It [life] has radically changed [the environment]. For the better, we might say, but who knows what was asking the question then!"

One of the things life has done is infuse the atmosphere with oxygen, something that wouldn't have happened without photosynthetic plants and bacteria. But that's not the only effect. "A lot of [marine] organisms secrete

calcium carbonate shells, and they get deposited in the ocean," says Head. "That takes a huge amount of carbon dioxide out of the atmosphere."

Another factor that has helped is simply the continued existence of large quantities of water. Partly that's just because the oceans are a huge heat sink, capable of damping short-term variations in climate. But some of that water is dragged beneath the surface in subduction zones via waterlogged sediments, where it helps lubricate the process of plate tectonics.[15] "It's not well known how it acts," says Michael Mischna, a planetary scientist at NASA's Jet Propulsion Laboratory, "[But] it allows plates to slip and slide against each other. When you lose that, it locks everything up, like an engine seizing."

The third factor is the Moon. The old theory was that its gravity somehow stripped off excess atmosphere, keeping us from getting Venus-style hot. The new theory is that the Moon helps keep ice ages from becoming too severe. The best way to see how this works is to look at Mars.

Mars, Head and other scientists are finding, has long undergone substantial wobbles in its spin axis—wobbles that have wreaked havoc on its seasons. [16] Working backward in time, he says, it's possible to calculate the effect of perturbations from other Solar System bodies on the tilt of Mars's axis. "You can see it's whipping like a whiplash," he says.

In the past few million years, he's found, it's ranged from very little tilt to an angle of 35 to 40 degrees. In fact, he says, there's a reasonable chance Mars could practically flip over on its side, tilting by 70 or 80 degrees.[17]

The Earth also sees variations in its tilt, but only by a few degrees. Even these are large enough to launch (or end) ice ages. The difference, Head and others say, is that the Earth's spin is stabilized by the Moon. "Mars has just these two little space potatoes, Phobos and Deimos, which don't really do much," Head says.

Mischna adds: "Without something like the Moon, essentially locking the Earth into place, the axial tilt tends to wobble back and forth. That's what we see on Mars: a very large wobble. We have only very subtle changes. That keeps the planet pretty much stable relative to Mars."[18]

* * * *

So, what of the future?

In the long run, the Sun is continuing to heat up and eventually Earth's climate will go the way of Venus's.

"Venus shows us what happens to an Earthlike planet when the input of solar radiation gets over a certain threshold," Grinspoon says.

But there's no hurry building a spacefaring ark: the Sun probably won't get hot enough to boil off the oceans for a billion or more years.

As for our own effects on climate, the good news is that in the million-year long run we're more likely to ruin ourselves than the Earth's climate as a whole. But that doesn't mean it's impossible to do both. "Both Venus and Mars seem to have gone from habitable to uninhabitable," Grinspoon says. "That should give one pause about messing with one's planetary climate without a complete understanding of the limits of that stability."

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1 See R. A. Lovett, "From Fimbulwinter to Dante's Hell: The Strange Saga of Snowball Earth," *Analog*, Jan/Feb 2006.

2 Technically, the Earth and Moon aren't quite unique. Pluto's moon Charon is also large, and other Kuiper Belt objects come in pairs. But none of them are in the habitable zone.

3 For more on this, see an un-bylined article in the online edition of *Astrobiology*, February 7, 2007.

4 Environmental concerns about acid rain involve another acid, sulfuric acid, produced, in part, by the burning of sulfur-containing fuels.

5 Ideally, we could rely on this process to abate our current climate concerns. Unfortunately, it's slow by human standards, requiring, by most

models, thousands of years to remove the extra carbon dioxide we're injecting into the air by burning fossil fuels.

6 See, for example, "Messengers from the Earth's Core? The Great Plume Debate Heats Up," *Analag*, July/August 2006.

7 Press release from the European Space Agency, dated 18 December 2008. Such press releases can be found at www.eurekalert.org.

8 This study was reported at the fall 2008 meeting of the American Geophysical Union. Abstracts for this, and other studies from that meeting, can be found at www.agu.org.

9 The same method has been used to map layers in the Martian ice caps, all the way down to bedrock. See www.nasa.gov/missionpages/MRO/multimedia/phillips-20080515.html.

10 See Richard A. Kerr, "Signs of Plate Tectonics on an Infant Mars," *Science* 30 April 1999, pp. 719-722.

11 For a more detailed explanation, see: sunearth.gsfc.nasa.gov/sunearthday/2004/vtdynamoplaetary2004.htm. [Sic: the typo "plaetary" is in the URL.]

12 For more, see www.space.com/scienceastronomy/planetearth/moonwhackside000901.htm.

13 See: R. A. Lovett, "Texas-Sized Asteroid Slammed Early Mars," *National Geographic News* (online), June 25, 2008.

14 In Roberts' model, as little as a 1% drop in heat flow from the core can be enough to shut down the dynamo. Restarting it would require the heat flow to rebound by a full 25%.

15 In 2007, for example, seismologists calculated that an enormous mass of squishy rock beneath China contains an amount of water comparable to the

Arctic Ocean. See, R. A. Lovett, “Huge Underground ‘Ocean’ Found Beneath Asia,” *National Geographic News* (online), February 27, 2007.

16 Traces of these cycles appear in several ways. One is in the carving of gullies by what appears to be melting snow, which, Head and coworkers believe, appears to have fallen repeatedly in certain highlands over the past few million years. Only massive climate cycles—the Martian equivalent of ice ages—would allow snow to melt from the ice caps, fall in the highlands, then melt again. Other, more ancient, evidence appears in “layered deposits” in a region called Arabia Terra. In a presentation at the 2008 Lunar and Planetary Science Conference in League City, Texas, Kevin Lewis of CalTech used high-resolution orbital photos to examine these sediments in three dimensions, at one-meter resolution. His team found a regularly repeating succession of layers, indicating that Mars was probably undergoing regular climate cycles even very early in its history, when these sediments were being laid down.

17 See www.planetary.brown.edu/htmlpages/publications.htm.

18 Venus, on the other hand, has no moons but no substantial wobbles, possibly because of its much slower spin (Venus rotates once every 243 Earth days.) Thus, there are spin states, Grinspoon says, that are stable without the presence of a large moon. But in the case of Venus, the price is very long days. Also Venus has no significant axial tilt, which means no seasons.

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Probability Zero: A FLASH OF LIGHTNING by Robert Scherrer

Mr. Schonfield hunched over the chronopod control panel on his desk, checking the settings and taking attendance until the bell rang. "Ladies and gentlemen," he said, "welcome to Applied History I. We will spend this semester exploring cause and effect in American History prior to the Civil War." One of the Salem High School students glanced down at his schedule and skulked out of the classroom. Schonfield gestured toward a gleaming metal cylinder propped up against the wall behind his desk. "And of course, the thing that makes it possible for us to tinker with the past is the Weiser chronopod. Before the invention of the Weiser field by Jason Weiser back in '33, there were two dominant theories about time travel. Can anyone tell me what those were? Yes, Ms., uh, Bradbury."

Terri Bradbury delicately removed a wad of chewing gum from her mouth and placed it on her desk. "Well," she said, "there was this one idea that the past couldn't be changed."

"Yes," said Schonfield. "That was one theory. And the other one was...?"

"Uh..." Terri riffled through the textbook. "Not sure."

"Okay," said Schonfield, "the other theory was that a tiny change in the past would have huge consequences in the future. People used to talk about a rock thrown in a pond. The ripples spread outward, producing bigger and bigger effects as you move forward in time. And which theory turned out to be correct?"

Terri raised her hand. Schonfield smiled. "Yes, Ms. Bradbury?"

"Is this going to be on the exam?"

Schonfield scowled. "I haven't decided yet. But the answer is that *neither* theory was correct, as we will see today. I'm going to activate the Weiser field, and we'll take our first trip of the semester, all the way back to the

Cretaceous." Schonfield leaned over his desk and flicked a switch. The walls of the classroom vanished, and hot, humid air buffeted the students.

Terri wrinkled her nose. "Eew, what is that smell?"

"Rotting vegetation, mostly," said Schonfield. "The world's future petroleum supply." The classroom, minus walls and ceiling, nestled in a fern-covered valley, flanked by steep forested hills on all sides. Schonfield pointed to one of the hills. "After school today, I will use the Weiser field to bring a twenty-kiloton nuclear device to the other side of that hill, about ten miles away. Now, watch and learn." He pressed a button. Purple-white lightning wreathed the hill, followed by a low rumble that shook the classroom. A few students dived under their desks.

"Relax," said Schonfield, "it's just an atomic bomb, not an earthquake. We'll be gone before the fallout reaches us. Now, by my calculations, we have exterminated several hundred dinosaurs, thousands of smaller animals, and millions of plants. Let's see how this affects the future."

Schonfield fumbled with the control panel, sliding ahead to the Eocene. A lone Eohippus scurried through the grass. "At this point," said Schonfield, "we're viewing the newly-altered timeline outside the classroom. But the Weiser field also allows us to display the original, unaltered timeline." He punched a button and a sepia-colored scene superimposed itself over the outside view. A sepia herd of Megacerops grazed at the rim of a lake. "Note the rather large change we've produced. Our tampering has wiped out those weird-looking rhinos and that lake."

"That's really mean!" said Terri.

"We haven't killed them," said Schonfield. "They simply never existed in the new timeline we've created."

"It's still mean."

"We'll discuss the ethics of time travel in the spring semester. Now let's make another jump, ahead to nineteenth-century Salem." Schonfield slapped the switch with his palm, and a handful of rickety wooden buildings

appeared, crowding around a rutted dirt road. A dry wind blew dust across the classroom floor.

"Welcome to the Old West," said Schonfield.

Terri coughed. "Yuck, it smells bad here, too," she said.

"As we explore history this semester, the one thing you'll have the most trouble getting used to is the smell. As Jason Weiser said, 'History stinks.' It's just a consequence of the horse-drawn transportation system."

As if on cue, a rider plodded up the street on a mangy, dirt-colored horse. A woman fluttered out of one of the buildings, arms outstretched to greet him. Schonfield hit a button, and a sepia version of the Old West popped into view. The sepia buildings, along with the horse and rider, tracked their newly altered counterparts, but the woman was nowhere to be seen.

"Note the more subtle changes," said Schonfield. "The buildings, the horse, the rider appear in exactly the same location, but our distortion of the timeline has added a woman friend. Does that make up for the rhinos, Terri?"

"It's cute," said Terri. She grinned. "You're a regular matchmaker, Mr. Schonfield."

"Okay," said Schonfield, "now let's go home." He flicked the switch, and the classroom popped back to its original space-time coordinates at Salem High. A gaggle of students strolled across the lawn just outside the classroom window. "Let's see how we've changed the present," said Schonfield. He tapped a button, and a sepia group of students appeared, superimposed exactly over their real counterparts. One of the students stepped a few inches to the right of his sepia doppelganger, crushing a moth in the grass.

"We now know," said Schonfield, "that neither theory of time travel was correct. We *can* change the past, but the time stream has its own kind of friction. Colossal changes are slowly damped with time, until—" Schonfield stepped out the classroom door and retrieved the mangled body

of the moth “—there are almost no discernable changes at all. Does anybody know what this friction effect is called? Anyone?” The students fidgeted silently. “This *will* be on the exam,” said Schonfield. He held up the dead moth. “We call it the Butterfly Effect.”

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Short Story: **THE JOLLY OLD BOYFRIEND** by Jerry Oltion

Wherein the Ghost of Christmas Present gets a whole new meaning....

Gina couldn't sleep. She and Todd had been in bed for maybe an hour, but they'd gone there angry after another of their pointless arguments, an argument about how to stack the coffee mugs, of all things, and Gina couldn't put it behind her. Todd had broken two mugs, tipping them out of the cabinet onto the countertop just to prove that they were unstable the way she'd put them in there. Never mind that she'd never broken one in her life, never mind that they were *her* mugs and this was *her* apartment.

Worse, tomorrow was Christmas, and she was afraid of what she might find under the tree. She'd been pressuring Todd for an engagement ring. What if he had bought her one? What if he hadn't?

He didn't sleep over every night, but it was getting more common. They'd been talking about him giving up his apartment and moving in. Now she didn't know. She'd thought she wanted that, but after an evening that ended with broken coffee mugs she wasn't sure.

She was running it around and around in her mind when she heard a crash in the living room. A crash, a thump, and "Ow, ow, ow!" in a voice that she thought seemed familiar but couldn't place.

She jerked upward and grabbed the flashlight she kept on the headboard, but she didn't turn it on. No sense attracting trouble. Beside her, Todd raised his head and murmured, "Mmm?"

"Someone's in the living room!" she whispered.

He sat up quickly, overbalanced, and grabbed her arm for support, then turned and fumbled for the can of pepper spray she kept beside the flashlight.

"We're armed!" he shouted, his voice half an octave lower than usual. "Leave now and nobody gets hurt!"

There was another thump in the living room, then a light came on. "I'm sorry," came a voice, male, definitely familiar. "I'm ... I think I'm lost. I'm not dangerous."

"Who are you?" Gina shouted.

"Dumb!" hissed Todd. "Now he knows there's a woman here."

The intruder had given a name, but she hadn't heard it over Todd's criticism and the beating of her heart.

"Who?" she said again.

"Be quiet!" Todd said, and she missed the name again.

From the living room the voice said, "Where am I?"

Todd shouted, "You're in the wrong place, that's where you are. Get out of our apartment right now."

"Right. Sorry. I don't know how I got here. Sorry about the fireplace. I'll just ... Gina?"

The voice clicked. Her old boyfriend, the one who had dumped her for the sorority girl six months ago.

"Sergei," she whispered. Here in her apartment. But he was supposed to be dead. She'd gotten email from Christy about it just a couple weeks ago. A car wreck in Kazakhstan or something while he was visiting the homeland with his parents. She'd cried, even though she was still mad at him. But there was no mistaking that voice, that faint hint of a Russian accent even though he'd been born in Wisconsin to second-generation immigrants.

To Todd she said, "Pepper spray the bastard."

"Gladly." Todd threw the covers aside and rose out of bed, silhouetted against the light coming from down the hallway. He strode out into it like a Greek god, his shoulders wide and his tight little butt rippling with muscle. He made it to the end of the hallway, just out of her line of sight, but instead of the hiss of pepper spray and the howl of anguish Gina had expected, Todd burst into laughter.

"What?" Gina said. She jumped out of bed and grabbed her bathrobe, swirling it on as she rushed out after him to see what could be so funny about Sergei Popovich in her apartment on Christmas Eve.

Todd stood there at the end of the hallway, shaking his head. Across the living room stood Sergei, dressed in a Santa suit and covered with soot and ash from the fireplace. His hat and fake white beard were both askew. He was holding his arms out, hands wide open to show they were empty. At his feet rested a lumpy red cloth bag.

"I'm really sorry," he said again. "I don't know how I got here." He stumbled a little and reached for the arm of the couch to support himself, and for a second Gina saw the photos on the mantel right through his chest.

Holy shit, he really was dead. Her heart, already beating hard, took off at a totally new speed.

She stepped past Todd and took a good look at Sergei. "What are you doing here?" she asked.

"I ... I must have unfinished business," he said. "The last thing I remember is the front end of a bus coming at me. I'm dead, aren't I?" He sat down heavily on the hearth. The brass handles of the fireplace doors rippled in and out of visibility through his chest.

"All right, this is weird," Todd said.

"Tell me about it," Sergei replied. He looked up at Todd, then at Gina, then he took a deep breath and pushed the bag of toys aside and knelt down on the carpet where they had been. "I don't know how long I've got, so let me start with an apology. Gina, I was a total idiot. I treated you badly, and I

apologize. I have no excuse and no explanation. If you can ever forgive me, I'll ... I'll rest in peace."

Gina had dreamed of this very moment, of him realizing his mistake and apologizing, and in her daydreams she had always told him to get lost, but now, faced with his returned spirit, she couldn't do it. "Apology accepted," she said softly.

There was a long moment when nobody breathed. Sergei didn't disappear. After a few seconds he said, "There must be something more." He stood up, looked to the sack at his feet, picked it up, and untied the cord at the top. "I appeared in your fireplace in a Santa suit with a sack of presents. Maybe I'm supposed to deliver them to you." He reached into the sack and pulled out a four- or five-inch cubic box wrapped in glossy black paper with a silver metallic bow on top. He read the tag that dangled from the side, and said, "For Todd. That must be you."

He held it out for Todd, and Todd took it gingerly from his hands.

"It's heavy," Todd said.

"Probably a lump of coal," Sergei said. "Ha ha. Little joke. Aren't you getting cold?"

Todd looked down at himself, naked as a jaybird, and nodded. "Don't do anything stupid," he said and retreated into the bedroom.

Gina looked at Sergei. Sergei looked at her. There was something in his eyes, something in his expression, a longing that took her back to the very first days when they'd started going out. They hadn't been able to get enough of each other. The chemistry was obviously still there.

Sergei pulled the fake beard down below his chin. "You look beautiful," he said.

She swallowed. "You look pretty good yourself, especially for a guy who's been hit by a bus. Oh, Sergei! Why did it end like this?"

"Because I was stupid," he said. "I didn't know what a rare and wonderful person you are, and I—"

"That's enough of that," Todd said, coming back into the living room in pants and a sweatshirt. He still held the black package in one hand, and the pepper spray can was tucked in his waistband. "You apologized, she accepted, end of story. Let's move on." He walked past Gina and did what she had been unable to bring herself to do: He reached out and touched Sergei. Grabbed his shoulder. "You're pretty solid for a ghost, there, bud."

Sergei didn't shake off Todd's hand. Instead, he reached up with his own hand and touched himself on the face. "I do seem to have a little more substance than the usual ghost, don't I?" he asked. Yet when he turned, Gina could see the fireplace right through his chest. Not clearly—it was like looking through fog—but he was definitely not solid there.

"Let's try walking through something," Sergei said. He moved to the side and stepped toward the couch. Todd dropped his hand. Sergei walked forward tentatively and stuck one leg out as if he was trying to walk right through the couch's armrest, but he clonked his shin against the wood. "Ow! Okay, no passing through stuff."

"You know," Todd said, "I don't think you're dead. I think you're just some schmuck who broke into our apartment and thinks he can make up with an old girlfriend."

"I would be very happy if you were right," Sergei said. "How can we test this theory?"

Gina snorted. "We can see right through you! Jesus, Todd, give the guy a break."

"No, no," Sergei said. "He has a point. This could all be an elaborate hoax. I am ... was ... a physics student. There could be some new breakthrough in optics that allows me to project an image around my body." He narrowed his eyes, thinking, then snapped his fingers. "The internet. Look for my obituary."

"You're kidding," said Todd.

"No. Try it. If I was hit by a bus in Kazakhstan, it should be on the internet." He shivered. "And if I wasn't, then maybe I am ... somehow ... still alive! Maybe I was just injured, got amnesia, and made my way here. This was Gina's apartment when we were dating, and that was one of the happiest times of my life; it makes sense that I might return here if I were searching for my identity."

"Yeah, right, in a Santa suit," Todd said.

"It is Christmas, isn't it? Maybe I mugged a Salvation Army bell-ringer for clothing."

"And stole his bag of presents, one of which has my name on it? Come on."

"You're right," Sergei said. "It's far more likely that I'm dead." He reached out to the mantelpiece to steady himself, and Gina watched the fireplace bricks ripple through his insubstantial body.

She turned away and went into the kitchen, where she had left her laptop computer on the dining table. She lifted the cover and waited for it to wake up, then opened a browser page and typed "Sergei Popovich obituary" in the search box.

The top hit was in Russian. She clicked on the "translate this page" button and walked into the living room with the laptop in her hands as the page loaded. She read the text aloud as it scrolled onto the screen: "December 15. Killed today in automobile collision were Anatoly and Maria Popovich, their son Sergei, and daughter Annya. Vehicle driven by Popovich collided with—"

"Annya too?" wailed Sergei.

"That's what it says here. I'm sorry." She didn't offer to show him the picture of the little car wedged in under the front of the bus. Dozens of bus passengers stood around on the snow-covered ground, looking at it in that curious but detached way that people do after they've been on the scene for

a while. One of the passengers was taking a picture up the valley, which was full of snow-covered trees.

Sergei reached into his sack again. "Let me finish this so I can go back to oblivion. I can't stand this." He pulled out another present, this one smaller and wrapped in green and red paper with a red bow on top. He read the tag. "Michael? Who's Michael?"

"The kid next door?" Gina said.

Sergei's eyes narrowed. "Mickey?" He reached into the bag again and came up with another present. "Elaine. That's Mickey's little sister, isn't it?"

Gina nodded.

"Maybe you can give these to them in the morning." Sergei set both presents on the couch and reached into the bag again. This time he came up with a tiny gold-foil package with a silver bow. "Ah, Gina," he said, reading the tag. He held it out to her.

She set the computer on the couch and took the package. "Should we open them now?" she asked.

Sergei looked down at his quasi-insubstantial body. "I don't seem to be disappearing completely yet. Maybe you should."

Gina looked at Todd. Todd looked at her, then at Sergei. "If it'll help get you out of here, okay, rip away," he said. He grabbed the bow on top of his package and wrenched it loose, pulling a long strip of paper away with it.

Gina popped the tape on hers with a fingernail, peeled the paper back, and saw the classic round-edged velvet box that jewelry came in. Her heart had been slowing down a little, but it started beating faster again. Jesus, was it a ring? Before they broke up she had been hinting at Sergei—okay, more than hinting—that she wanted to get married. Could this be the engagement ring she'd never gotten? But now she was practically engaged to Todd! That ring was probably under the tree.

She looked over at Todd, who was just opening the box he'd freed of its paper. He shook out a shiny, irregular black rock about the size of his fist.

She laughed. She couldn't help it.

"You bastard," Todd growled. He lunged for Sergei and punched him in the face. Sergei staggered back and fell against the fireplace tools, scattering them across the floor.

"Todd! Stop it!" Gina dropped her present and grabbed Todd and pulled him back while Sergei struggled to get up. Sergei's hand gripped the dustpan, and Todd pulled the can of pepper spray out of his belt and sprayed him square in the face.

"Aaaggh!" Sergei yelled, turning aside and covering his eyes with his hands, but it was too late. He started sneezing and coughing and blubbering uncontrollably, and Gina found herself sneezing and coughing, too.

"Damn it, Todd, what did you do that for?" she shouted.

"He was going for the poker," Todd said.

"Bullshit. He had his hand on the dustpan."

"And he gave me a lump of coal!"

"You maced Santa Claus because he gave you a lump of coal?"

"He's not Santa Claus."

Sergei was crawling into the kitchen, trailing snot and tears and soot and ash behind him as he went. Gina helped him to his feet and propelled him into the bathroom instead, where she stuck him into the shower and turned the water on full blast.

"Aaaii!" he yelled again, but this time it was probably just because the water was cold. He eagerly stuck his face into the stream even so, and let it wash off the pepper spray. The Santa suit was getting drenched, though, and

the shower tiles that Gina could see through it sagged along with the water-laden cloth.

Someone was banging on the front door. "Stay there," she told Sergei, and went to see who it was.

Todd beat her to the door. Charlie Dixon, Mickey and Elaine's dad, stood there in his pajamas. "What's going on in there?" he asked.

"Nothing that concerns you," Todd said belligerently, and Charlie took a step back, but Gina said, "We're having an argument, but Todd was just leaving."

"I am not," said Todd.

"Yes, you are," Gina said, grabbing his coat off the back of the chair by the door and handing it to him. "You wouldn't want Mr. Dixon to have to call the police, would you?"

Charlie looked past Todd at her. "You're crying," he said.

"It's just pepper spray," said Gina.

"Pepper spray? Are you all right?"

"I will be as soon as Todd leaves," Gina said.

Todd turned toward her with the pepper spray in his hand, but Gina held her ground. "You're an arrogant bastard, and I want you out of my apartment. Now."

"I think you'd better do what she says," said Charlie.

"Or what?"

"Or you'll be spending Christmas in jail."

Todd considered that for a moment, obviously weighing the idea to see if it would be worth it. Apparently violence came up short. He turned to Gina.

"If that's the way you want it."

"I do," she said.

"I'll be back for my stuff later."

"It'll be in a box by the front door."

He gave her one last withering look—the same look she'd given Sergei when he'd announced that he was breaking up with her—then shoved his way past Charlie and stomped down the stairs. The door banged against the wall, then shut behind him.

"I'm sorry we woke you up," Gina said to Charlie. "Oh, wait a minute..." She ran into the apartment, grabbed the presents for Mickey and Elaine from the couch, and brought them back to him. "These are from Sergei. You remember Sergei?"

"I do," Charlie said. "And if you don't mind my saying so, I liked him a lot better than that doofus you just kicked out."

"Me too," said Gina.

He hefted the presents in his hand. "You have a Merry Christmas," he said.

"Thank you. Merry Christmas to you, too." She closed the door as he turned away, then rushed back to the bathroom, half afraid that Sergei would have vanished, but he was still there, stripped to the waist and mopping his face with a towel.

"I have one last apology to make," he said.

"For what?"

"For not being dead."

She looked at him standing there in the bathroom, his hairy chest as solid and inviting as ever. The Santa jacket lay in a sodden heap on the floor, its surface shimmering slightly with light that didn't reflect quite true.

"This was all a trick?"

"The apology was genuine," he said. "I was a total jerk, and if it takes me a hundred years to make it up to you, I'll dedicate my entire life to the effort. The see-through Santa suit, though; well, let's just say the physics lab has been doing some interesting things with waveguides."

"So you figured you could fake being a ghost and—and what, scare Todd off?"

"Nothing so simple. I'd heard stories about him. I figured I'd put him under some stress and let him show his true colors. It worked a little better than I expected." He sniffed, wiped his face with the towel, and grinned the foolish grin she remembered from so many good times before.

Was this a good time? She didn't know. Her whole life was in a shambles, and so was her apartment. But she'd felt that moment of connection when she'd looked into Sergei's eyes in the living room, and that had been one of the happiest—well, the *richest*, anyway—moments in recent memory. Sergei could certainly get her heart beating again, and not just by startling her.

And she supposed he could put up a web page with a fake story about his death. Since it was unlikely that any other Sergei Popoviches had died in the last few weeks, his would be the first one returned by a search engine.

"Why did you leave me for that vacuous blonde?" she asked him.

He was already red, but his face grew even redder. "Um. Truth? You wanted to get married so bad, it scared me."

That was the last thing Gina expected to hear. She opened her mouth to protest, then shut it without saying a word. She had bugged Sergei about it over and over, and since he left she'd been pushing Todd just as hard. She really did want to be married, for the companionship and the security it represented, and who knew why else. She had never really thought it through. She just knew she wanted it. Apparently a little too much.

"Okay," she said. "Guilty. What now?"

Sergei stepped around her and went into the living room, where he retrieved her half-opened present. "Now you open your gift," he said. "I got you a lump of coal, too. Slightly more compressed than Todd's."

He knelt down in front of her and waited for her to open the package. She took her time, savoring the moment.

It was the most beautiful ring she'd ever seen. It was two braided ropes of gold and silver, swirling around each other to encircle her finger and coming together at the top to encage a glittering diamond.

"Gina, will you marry me?" Sergei asked.

She could hardly breathe. She had to swallow twice before she could find her voice.

"Let me think about it," she said.

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Reader's Department: **THE ALTERNATE VIEW: OPUS 150: DARK FORCES IN THE UNIVERSE** by John G. Cramer

This column is a milestone. In 1983, while I was on a one year sabbatical at the Hahn-Meitner Institute for Nuclear Physics in what was then West Berlin, I received a letter from Stan Schmidt informing me that Jerry Pournelle had decided that he no longer wished to be an Alternate View columnist for *Analog* and asking if I was interested in taking over as the AV columnist and “alternating” with G. Harry Stine.

This was a problem. At the time I had written about 80 papers for physics journals and a few science-fact pieces for *Analog*, but I was well aware that writing science fact for a popular audience is harder and more time-consuming than it looks, and the idea of having to produce a sensible column for every other issue of *Analog* on a regular basis was scary. I was not at all sure that I would have anything to write about when the deadlines came around. But I decided that the *Analog* soapbox was too tempting to pass up.

Fast forward to today. This is column number 150. Somehow, for over 25 years I have managed to meet each deadline with something (I hope) interesting to say about science in general and physics in particular. I think that popularizing science and making it accessible to interested readers is an important activity, and I hope you agree. With that said, let's consider the subject of this column: possible indications of a new “dark” force in the universe.

* * * *

It is now clear that our universe is a much stranger place than we had imagined only a decade ago. Its total mass-energy, according to our best cosmological models, divides up as 70% dark energy, 25% cold dark matter, 4% free hydrogen and helium, 0.5% stars (mostly hydrogen), 0.3% neutrinos, and only 0.03% atoms of elements heavier than helium, the stuff that we are mostly made of.

Dark energy, easily the most mysterious of these components, is an intrinsic energy of space spread uniformly through the universe and possessed by each otherwise completely empty volume of space. It creates a repulsive “pressure” that is accelerating the expansion of the universe. Dark matter, the next most mysterious, is some unknown form of mass that does not make or absorb light and interacts gravitationally with itself and with the normal mass of stars. Dark matter clusters around galaxies in a more-or-less spherical “halo,” accounts for most of the galactic mass, and causes stars in the outer reaches of a galaxy to orbit the galactic center much faster than they would in the absence of the dark matter halo.

But what is dark matter? It is definitely not ordinary matter (atoms, molecules, electrons) or any of the known fundamental particles including neutrinos. So what's left? Nothing ordinary, so we are pushed into speculating that dark matter is made of a previously unknown family of particles. Some theories that attempt to extrapolate beyond the standard model of particle physics predict new particles: e.g., supersymmetric particles, WIMPs, axions, etc. For the purposes of this column, we'll refer to them all as DMPs (i.e., dark matter particles).

How do you look for DMPs? There are basically two techniques: (1) We assume that a speeding DMP can collide with a normal nucleus, giving it enough recoil energy and momentum to trigger a sensitive detector, and (2) We assume that DMPs come in matter and antimatter flavors that can annihilate with each other and produce radiation detectable with sensitive instruments in space. Both types of DMP searches have been going on for some time, and are getting results that are both interesting and confusing.

Gran Sasso, located about 130 km from Rome, is the highest mountain in the Apennines of Central Italy. In 1995, twin highway tunnels connecting Rome to Teramo were cut through the mountain, and at the same time an underground particle physics laboratory was created there, consisting of three large underground low-background chambers shielded from cosmic rays by 1,400 meters of rock. In one of these chambers is the DAMA/LIBRA experiment, operating a cluster of sodium iodide detectors with a total mass of 250 kg (1/4 ton), designed to detect small signals arising from the collision of a DMP with a nucleus. When a nucleus recoils

from a DMP hit, a small flash of light is made by the resulting ionization, and this light flash can be detected with photomultiplier tubes. The DAMA detectors can observe such signals over background with energies as small as two thousand electron volts or 2 keV (here keV means kilo electron volts, the quantity of energy needed to move one electron across a potential of 1,000 volts). DAMA has a lower threshold than that of most competing DMP searches. DAMA/LIBRA and its previous incarnation as DAMA/NaI have been operating in the very low-radiation Gran Sasso environment for a total of 11 years. During this long period of operation, some interesting and controversial data has been collected.

In its yearly orbit around the Sun, the Earth has a speed of about 30 km/s. Our sun orbits the galactic center with a speed of about 220 km/s. If our galaxy is embedded in a cloud of DMPs more or less at rest with respect to the galactic center, the Earth passes through the DMP stream with a varying speed. At some times during its orbit, the Earth's speed adds to the Sun's speed, and at other times it subtracts. Thus, the DMPs streaming through the DAMA/LIBRA detector are expected to hit the detectors with more energy in June than in December.

Therefore, one of the signals examined by the DAMA/LIBRA collaboration is any annual variation in the counting rates in the detector, and indeed they have found such a variation at about the 2% level in counts with energies between two and four thousand electron volts (2 to 4 keV). As expected, the signal reaches a maximum around June 2, just when the Earth and Sun speeds add. The variation has a period of exactly one year with a 0.2% uncertainty. They attribute their observations to the presence of DMPs in the galactic halo and ascribe a confidence level of 8.2 standard deviations to their result.

The problem is that other similar DMP detectors (Zeplin III, CDMS 2008) with a different detection medium and higher energy thresholds see no such effect. Also, the 2-4 keV signals seen by DAMA/LIBRA are lower in energy than is theoretically predicted for DMP-nucleus collisions. Therefore, the DAMA/LIBRA result has been the subject of debate and controversy at several recent international conferences.

* * * *

As mentioned above, the other way of searching for DMPs is to look for space radiation produced when somewhere a DMP and anti-DMP annihilate. One particle expected from such annihilations is the positron, the antimatter twin of the electron. The PAMELA detector, launched on a Russian satellite by the WIZARD collaboration, has recently reported an observation of the ratio of positrons to (electrons + positrons) in the energy range 1.5 to 90 GeV. (Here, 1 GeV is 109 eV; for reference, a proton has a mass-energy of 0.938 GeV.)

The theoretical expectation is that such energetic positrons should be produced mainly in gas collisions during the propagation of cosmic ray protons in the galactic medium, and this leads to a positron ratio that should fall steeply with energy. The actual data, however, shows a strong *increase* in the ratio with energy, starting at a value of about 0.05 at 10 GeV and rising to above 0.15 at 90 GeV. There are similar reports of a positron excess in the 600-800 GeV range from the balloon-borne ATIC cosmic ray detector, but these seem to be in conflict with recent GLAST/Fermi results. This excess of energetic positrons is not easily explained, and could be the result of DMP-anti-DMP annihilation.

The WMAP experiment, which has mapped the cosmic microwave background with great precision, has also reported a hard microwave “haze” coming from the center of our galaxy, not readily explained by known galactic emission mechanisms. This haze could be the synchrotron radiation from energetic electrons and positrons made in DMP-anti-DMP annihilation near the galactic center. Studies there with the EGRET gamma ray detector showed an excess of gamma rays at energies above those expected from pi0 meson decays. It is suggested that the observed gamma rays might arise from the inverse Compton scattering of energetic positrons and electrons colliding with starlight and cosmic background microwaves.

Thus, from several independent sources there is evidence of energetic electrons and positrons, possibly coming from DMP-anti-DMP annihilation. On the other hand, there is no corresponding evidence of any excess of strongly interacting particles like pions and antiprotons, which would be expected from conventional matter-antimatter annihilations. In particular, the PAMELA measurements place tight limits on the antiproton content of

cosmic rays, and EGRET measurements place similar limits on gamma rays from π^0 meson decays. Neither provides any indication of strongly interacting annihilation products.

These results present a paradox. If DMP-anti-DMP annihilations are producing electrons and positrons with energies of 90 GeV or more, why are these decays not making any excess of antiprotons or π^0 mesons? This is in direct conflict with expectations based on the standard model, so the observations may point to new physics beyond the standard model.

One version of such new physics has recently been suggested by Arkani-Hamed, Finkbeiner, Slatyer, and Weiner (AFSW). They propose a new “dark” force that acts only between the dark-matter particles. In this AFSW model, when there is a DMP-anti-DMP annihilation between dark matter particles that wander into each other, the particle momentarily produced in annihilation is the carrier of the new dark-matter force. And it is assumed that the force-carrier particle has a mass of around 0.1 GeV, so that its low mass constrains its subsequent decay into electron-positron pairs and/or pairs of gamma rays.

Also, because of this new force, as the particles approach each other before annihilation, an attraction due to the force occurs that increases the probability that the annihilation will occur. This is called a Sommerfeld enhancement, and it can increase the chances of annihilation by several orders of magnitude. And the AFSW model predicts that DMPs should interact primarily with heavy nuclei, giving lower recoil energies, explaining why only detectors containing iodine (like DAMA) or lead nuclei show small but detectable recoil signals.

The AFSW theory can, at the expense of postulating a new and previously unknown force, explain all of the observations described above and make predictions that can be tested by new experiments and observations. In particular, the AFSW theory predicts that, as more data is collected, the positron enhancement observed by PAMELA should continue to increase up to the highest energies that the detector can resolve (~ 270 GeV). As the sources of positrons become better localized in position, the theory predicts that sources of the energetic positrons should be broadly distributed rather than localized at the galactic center (e.g., at the black hole there).

When the LHC begins operation in a few months (a year late because of a major cryogenics rupture) the AFSW theory predicts observation of a striking signature of highly energetic electrons and positrons among the produced particles in the proton-proton collisions. There are also predictions for new observations from the GLAST/FERMI and HESS detectors that have recently been launched.

* * * *

What are the science-fiction implications of all this? If the picture painted by the AFSW theory is correct, the matter content of the universe is mostly dark matter with its own particles, forces, and interactions. It clusters around galaxies in a somewhat different way than do the stars and planets of normal matter, and it may have complexities and structures that we have not imagined. Are there the equivalent of atoms and molecules made of dark matter that are invisible to us except through their gravitational interactions? There are almost no antiprotons in our galactic neighborhood, but apparently there is plenty of dark matter and antimatter. Can we find chunks of dark matter and dark antimatter and annihilate them for energy and propulsion?

So there may be another force in the universe, a fifth “dark” force that acts only between “dark” particles that ignore us as we ignore them, passing invisibly through our stars and planets as if they were not there.

The surface has just been scratched in this area. For science fiction this has the makings of new kinds of energy sources and propulsion, and perhaps even a new “dark” territory to be explored by space travelers.

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AV Columns Online: Electronic reprints of over 145 “The Alternate View” columns by John G. Cramer, previously published in *Analog*, are available online at: www.npl.washington.edu/av.

The AFSW Theory:

N. Arkani-Hamed, D. P. Finkbeiner, T. R. Slatyer, and N. Weiner, “A Theory of Dark matter,” Physical Review D79, 015014 (2009), arXiv preprint 0810.0713v3 [hep-ph].

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Short Story: **THE UNIVERSE BENEATH OUR FEET** by Carl Frederick

* * * *

"Plan ahead" can only take you so far. . .

Jerry Oltion
**Foreign
Exchange**

Illustration by John Allemand



Illustration by John Allemand

* * * *

How you see the world depends on how you look at it....

* * * *

he disturbance in the ice perturbed the funeral.

Despite the grinding sounds from the ice beneath, Jerik chirped his attention on Harshket, the High Priest of the People of the Rippling Wall. The priest, four feet planted firmly on the ice, raised his other two to heaven and commended the recently deceased Master of the Fourth School to the Great God, the god of water, the god of good.

A few feet in front of the priest, that Master of the Fourth School, his life-bubbles still pressing him to the ice, lay motionless. On a circle centered on the priest, six of the people, the Beaters to Heaven, stood at the six points of the compass. And behind them, outside another circle, waited the mass of the people—including Jerik. Though he listened to the priest's words (he could hardly do otherwise), he ping-chirped very little; he didn't really care to register the details of the priest's movements. And standing behind Jerik, his friend K'chir ping-chirped not at all. Jerik could hear the tapping as

K'chir sequentially raised and lowered his feet in obvious boredom. The Master of the Fourth had been K'chir's master. Jerik knew the two didn't like each other and K'chir wasn't exactly crushed at the loss. Jerik sighed. He was still only in Third School. All he could do was hope.

At length, the priest lowered all six of his legs to the ice and addressed the inner circle. "Beaters," he intoned, "do your sacred duty. Drive the god-given life-bubbles from the deceased. Beat him well and true, and enable him to rise swiftly to join the Great God of the Water. Let the deceased rise far from the evils of the world and from the evil presence of the God of the Ice."

"Finally!" whispered K'chir. "I thought Harshket would never stop babbling."

Those standing in the inner circle clattered somberly to the corpse. Each raised two forward legs above the body and, at a chirp from the priest, brought them down and began pummeling the ex-Master of the Fourth.

A trickle of bubbles dribbled from the master's mouth and collected in a clutch on the ice. Additional life-bubbles, tiny but numerous, shook free from the master's body and leg fur, carpeting the ice and softening the ping echoes.

Ping-chirping steadily now, Jerik observed the beating. He was surprised how few life-bubbles the master had possessed. But then again, the master was very old. And for the most part, vitality equated to how strong one's contact with the ice was—and that depended on one's supply of bubbles. A shift of the current brought Jerik the scent of the corpse—a terrible smell of death. Jerik blew out water in revulsion.

The priest gave a sharp chirp and the Beaters to Heaven moved back, causing the corpse, lighter without its bubbles, to twitch in the current. All was quiet, except for a susurrus of respectful chirping—and the constant grinding from the ice. Jerik could tell from his pings that many of the people resented the grinding and groaning from below. He knew though, that K'chir was far from annoyed; he was excited that there might actually be a release from the constant boredom.

Very slowly, the Master of the Fourth began to rise.

Ping-chirping in respect, Jerik observed the body rising faster, gently twisting and rolling in the current. Jerik breathed in relief as the death smell faded.

Jerik added to the wall of sound as the people, as a whole, ping-chirped the deceased, following the body to heaven with their chirps. As the body progressed steadily higher, the chirp echoes grew ever more faint, until they ceased altogether—until all that remained of the Master of the Fourth was a thin lake of air on the ice, the merged totality of the master's life-bubbles.

"Well, that's over," K'chir whispered from behind.

"Not quite over," said Jerik.

The circle of mourners converged on the lake of air. In order of their seniority, the High Priest Harshket going first, they wallowed in the air, trapping minuscule bubbles onto their leg fur. The lake shrank until, when K'chir's turn came, there was no air left at all.

Jerik chuckled. "It's too bad, K'chir," he said. "It would have been really funny if you'd been able to absorb some of your master's essence—considering how much you hated him."

"I don't believe in that essence nonsense," said K'chir, turning away from the one-time air-lake. He tapped a leg in disgust. "But the air was certainly full of the master's scent. I'll survive just fine without it." He chirped a smile. "It's air. Life-giving air, certainly, but that's all."

"It's God's gift," said Jerik.

"Come on!" said K'chir. "I don't believe in any such god."

Jerik winced. He didn't believe either, or at least didn't think he believed, but saying so aloud was not wise.

"Let's get out of here," said K'chir. He and Jerik began to glide away, but the High Priest held up two legs.

"K'chir. Please wait until the others leave." The priest spoke in a voice that was threatening despite the courtesy. "I want to talk to you."

K'chir stopped, but Jerik, as quietly and unobtrusively as he could, continued to glide away.

"And you," said the priest. "Jerik, by your smell."

Jerik stopped abruptly. "Yes, sir?"

"Stay!"

"Yes, sir." Jerik glided back to Harshket. He waited nervously with K'chir as the chirps from the people faded away. Then Harshket, without preamble, said, "K'chir. Do you know the Six-fold Way?"

"Of course, I do. Every First School student learns it on the first—"

"Recite it," Harshket demanded.

"Why?"

"Recite it. Now!"

Jerik heard K'chir tap a leg in a quiet shrug.

"All right," said K'chir in a voice at the border between polite and put upon. "The qualities of the People of the Rippled Wall are: Obedience." He stamped his front left leg to the ice as custom required. "Loyalty." He stamped his front right leg. "Honesty. Knowledge. Wisdom." At the mention of each quality, he stamped another leg. "And Reverence," he intoned, stamping his sixth foot.

"Do you think you exemplify these sacred qualities?" said Harshket.

K'chir stood silent.

"From your comments that I and no doubt many others of the people heard," said Harshket, "I rather think you fail with regard to Reverence, the

highest of the qualities."

"I'm not sure I am fully a believer," said K'chir. Jerik noticed that his friend was being a lot more tentative than usual.

"Not sure?" Harshket raised his forward legs in the air and chirped, the rasping chirp of the elderly. "Can you not detect the sweet manna sent down from heaven by our kind and all-powerful god?"

"Maybe..." said K'chir in a cautious, even frightened voice. "Maybe the manna from heaven is just the dead—decomposed and sent back down to us."

"Nonsense!"

Jerik felt the turbulence of the current reflecting Harshket's anger—and then the turbulence subsided.

"Who, K'chir, do you think does the sending?" Harshket spoke in the voice of a philosophy master, which, of course, he was.

"The same one who sends down those," said K'chir. He pinged a stream of sulfur-bubbles coming from on high. "And why would God send down foul-smelling, inedible life-bubbles that burn our bodies?"

"To test our faith, of course. You know that." Harshket spoke as if he were addressing young children.

Jerik moved his mandible in a soft, unpingable show of amusement. *Of course, to old Harshket, everyone was surely a child.*

"You are in Fourth School—Collective philosophy," said Harshket, wearily. "Collective! Do you think you're setting a good example for your young friend who is only, if I recall correctly, in Third School—Deductive philosophy?"

"I think, sir, I am setting a good example. At least I'm trying to."

"Then you fall short in the quality of Wisdom as well."

Jerik sensed his friend bristle.

"Yes, I accept the Six-fold way," said K'chir. "But there are qualities it leaves out. What about Innovation? What about Adventurousness?" He chirped a sigh. "I'm so bored."

"Ah, so that's it." Harshket chuckled and Jerik breathed easier. He'd been worried his friend had been pushing the priest too far.

"Adventurousness," said Harshket, thoughtfully. "We have ice-gliding races, wrestling, debate rallies. Compete! That should address your boredom. Or perhaps you might study harder."

"I'm bored with all our rituals and traditions," said K'chir. "I want to create, to innovate."

"Me too," said Jerik, wanting to get into the game, now that High Priest Harshket seemed more disputative than angry.

"You are a mere juvenile, Jerik!" said Harshket, in a voice near anger. "And so young that your voice is almost as high pitched as your ping-chirp."

"Yes, sir." Jerik thought deference the safest course at the moment.

Harshket chirped a sigh. "And as to you, K'chir. You must wait until the Sixth School—Transcendental philosophy. Your time will come."

"Maybe our culture has gotten too old." K'chir lowered his head and soft-pinged the ice in an expression of sadness. "During our creative period, when we should be advancing the art, we're still learning what has gone before—studying philosophy, memorizing poetry." He chirped frustration. "And even then, we study narrower and narrower specialties until we cannot any longer see the whole. True innovation is impossible."

"That is known," said Harshket. "It is a sign that God's work for his people is almost done."

Jerik was afraid that would set his friend off, would make him say something he'd regret. But K'chir merely said, "I want more in life."

"More?" Now Harshket sounded angry. "Just what *do* you young people want?"

"For one thing," said K'chir, "true knowledge."

"Meaning what?"

"Well..." said K'chir in a light tone. He'd apparently also detected the edge in Harshket's voice and knew it could mean danger. K'chir pinged the ice. "I'd sort of like to know what that grinding beneath the ice is."

Clearly, K'chir was trying to lighten the mood.

"Things have come up through the ice before." Harshket's voice sounded troubled.

"They have?" said K'chir in a curious tone with no trace of challenge.

"You will learn about it in Fifth School next year."

"Please, sir," said K'chir, "would you tell me about it now?"

Harshket made a throaty chirp toward the ice and said, "It happened many great-tides ago." He spoke in a distant voice. "This *thing* came up through a fissure—a crack in the ice after a heaven-quake. And the thing came into the world upside-down. It had four feet rather than six. The feet pointed heavenward—a clear sign that it came from the God of Evil and Ice."

Harshket chirp-mapped the thing slowly and in exquisite detail. It took Jerik's breath away. The thing from the fissure had thin legs, rodlike with pads for feet. And it had a body with more rods sticking out nonsymmetrically from all sides. It seemed alive: a small shell-like object on its head swiveled back and forth, and it virtually reeked with frenzied electromagnetic waves. All this did Harshket transmit through a chirp-map, crisp and precise as if the priest had only encountered the object at last tide.

"And it rose toward heaven," Harshket continued. "Rapidly. Aggressively. It could be nothing else but the Ice God's demon rising to challenge the Great God."

Jerik felt the shimmering currents of Harshket's shivering limbs.

"Ice God, Great God," said K'chir in a voice of ridicule. "Well, I don't believe it."

"You are flirting with sacrilege, young man," said Harshket. "You of course know that people have fallen into fissures and have been pulled down into the realm of the Ice God."

"Down into the ice. Yes."

"They never came back," said Harshket with raised front legs. "Never!"

K'chir chuckled and Jerik marveled at his friend's courage—or foolishness.

"So is that what the grinding sound is?" said K'chir. "The Ice God coming to visit?"

"In a manner of speaking, it is," said Harshket. "It can only be the Antigod trying to break through because of the immorality and evil in the land."

"Well, *I* think," said K'chir, swirling the water with a leg, "that there's another world beneath the ice."

"Ridiculous," Harshket uttered a disdainful chirp. "You'll understand when you reach Sixth school."

"I'll *never* understand. I believe it *is* another world."

"If you are so contemptuous of philosophy, then tell me: How, other than going through a fissure, could the dead from this ... this other world reach heaven?"

"It could be," said Jerik, attempting to gain points with both his friend and the priest, "that we're chosen by God to be the guardians of heaven."

K'chir as well as Harshket returned a dismissive chirp.

"Or," said K'chir, "maybe there is no heaven and no god."

Jerik suppressed a gasp.

"Sacrilege!" Harshket roiled the water and then paused until the currents grew calm. "I must deliberate on this," he said in a voice of cold anger. "At first tide, come to me. I believe you must be corrected for your crimes against God. Both of you come."

Without another word, Harshket turned and scuttled away.

K'chir, with an audible scowl, glided away and Jerik glided after him.

"What will he do to us?" asked Jerik.

"He'll beat us, of course." K'chir chirped toward the Rippled Wall and the two glided in that direction. "Me for sacrilege and you for hanging out with me." After a few seconds, K'chir added, "He'll beat me more than you." Jerik sensed the currents as K'chir shuddered. "*Much* more than you." He sped up.

"Where are we going?" Jerik struggled to keep pace.

"I'm not going to stick around and let myself be beaten in front of all the people."

"You're not going to run away to another people," Jerik called from behind, "are you? It won't really do any good. It'll be just the same." Jerik shook in the turbulence of K'chir's wake.

"No," said K'chir without slowing down. "I'm going to prove philosophy is garbage and Experimentation is truth."

"What are you talking about?"

"I will prove that this god stuff is nothing but myth," said K'chir, breathlessly. "I am going to climb to the so-called heaven and look around."

"What!" Jerik grabbed his friend and the two spun around on the ice as if they were dancing. "You're joking."

"I'm serious."

Jerik dug the rough sides of his legs against the ice and their spinning slowed to a stop. He addressed his friend mandible to mandible. "They'll kill you for this."

"If God actually exists," said K'chir in an annoyingly logical voice, "then when I go down to the ice again, yes, they might kill me. But then I'd just float back up to God. He'll punish me, perhaps. But he's supposed to be good and kind. So, I expect his punishment will probably not be too bad. And anyway, I really want to know if there actually is a god."

"Have you been sipping sulfur-bubbles?"

K'chir chirped a weak smile and went on. "But then if, as I believe, there is no god—well, Harshket can tell if people are lying. He'll know I'm telling the truth, so there'll be nothing he can beat me for." K'chir clicked his mandibles, smugly.

"But climbing to heaven?" Jerik threw an exasperated ping upward. "That's impossible!"

"Why?" K'chir pinged in the approximate direction of the Rippling Wall, but they were too far away for an echo. "In bad times, the people had to climb ever higher for the edible growths on the rocks. That was long before you were born—before I was born either. That was before the people had learned to stabilize our population by rationing life-bubbles." He started gliding again toward the wall. "So I'll go to a wall and climb higher—to heaven ... to see what's there."

"What's there?" Again Jerik strove to keep up. "It's friggin' heaven! Are you so eager to die?"

K'chir sighed. "I'm bored to death already."

"Well ... well maybe the grinding in the ice will turn out to be something interesting. Maybe it's the thing Harshket saw."

"And maybe it isn't. I don't want to wait anymore. I'm climbing."

"I'm coming with you," said Jerik, firmly.

"What?" K'chir braked to a stop. "No. Finish school. Maybe Sixth School *will* have answers—at least for you."

Jerik stiffened his legs, drawing himself to his full height. "I'm coming with you!"

"This is very, very dangerous," said K'chir. "I'd rather you didn't do it."

"Don't make me say it again," said Jerik.

After a few seconds of exploratory chirps, K'chir crossed his forward legs in acceptance. "Fine. Then come." He started away but then turned. "And thanks. I appreciate your company."

K'chir leading, they headed toward the Rippling Wall, guided first by magnetic fields, then by chirp echoes, and finally by the smell of the stone.

With ping and claw, they explored the base of the wall, looking for a cleft, a place with good leg holds.

"How about this one?" said Jerik.

K'chir scuttled over. "It is good, very good."

Jerik began to climb.

"No, wait," K'chir called. "Let's rub down our legs and bodies first. To strip the life-bubbles from our fur."

"Why?" Jerik wasn't crazy about the idea. Life-bubbles were precious.

"To make ourselves lighter," said K'chir with a chuckle. "Not so light so we'd rise. We'd have to be dead for that." K'chir began wiping away the bubbles. "But if we fall, we'll hopefully drift slowly down to the surface and not hurt ourselves on the ice."

"Hopefully!" Jerik also pressed down his fur, leaving a small lake of air on the ice. "But we'll roll around in the bubbles when we get back. Right?"

"Of course!" K'chir began climbing.

Jerik followed after. "I guess," he said as he pinged the rock face, "if God didn't want us to climb to heaven, he wouldn't have provided footholds."

"Unless," said K'chir, "he was testing our faith." By voice alone, Jerik could tell K'chir's mandible was extended in amusement.

Using the cracks in the rock and the purchase afforded by the thick growths of edible molds clinging to the walls, K'chir and Jerik made quick progress. "At least we won't starve," said Jerik. He grabbed a snack from the wall. "But, boy, heaven is high!"

"Don't call it heaven."

"What should I call it, then?" said Jerik, breathing heavily.

After a few more vertical feet, K'chir answered. "There doesn't seem to be another word. But when you say it, try to keep the reverence out of your voice."

"Yeah. Sure. Fine."

"Is it getting warmer?" K'chir asked. "Or is it just the exertion."

"I think it *is* getting warmer. Heaven is supposed to be warm." Jerik moved a leg out into the current. "Yeah, it's warmer, but the current seems stronger too."

As they climbed, the growths grew sparser. "Well, there goes lunch," said K'chir.

The wall became smoother. "I wonder if the molds made the footholds," said K'chir. "Maybe the molds eat the rock."

"I'd really like some of those faith-testing cracks right now," said Jerik, breathlessly, trying with all his strength to cling to the wall.

The climbing became very hard and slow, and the wall had begun to slant inward.

Jerik cried out.

"Don't ping down!" K'chir commanded.

But Jerik had so pinged and now felt a queasy vertigo. And then came a sharp current, a tide. One part of his mind knew it was the first tide, the one at whose occurrence Harshket had demanded their presence. Partially distracted as he was, Jerik released a leg and rubbed it thoughtfully across his torso. His body shifted, and with a shriek, he began to fall.

K'chir reached a leg down. "Grab hold!" he shouted.

Jerik pinged, then leapt for the proffered limb and grabbed it with his two forward legs.

K'chir grunted in exertion. Then Jerik felt himself falling again, while he still had hold of K'chir's leg.

"Hey!" K'chir exclaimed in a cheerful voice. "This is great! Wiping off our life-bubbles worked."

After a short, panicked pause, Jerik said, "Yeah, it did!" His dread had turned to elation as he felt himself not falling, but drifting softly down to the ice. Now, without fear, he ping-chirped down. "Uh-oh!"

"What's the matter?" said K'chir.

"On the ice," said Jerik. "Three, maybe four sixes of people."

"And it is first tide, isn't it?" said K'chir, in obvious worry.

"I'm afraid so."

Jerik ping-chirped. "And there he is," he said with an anxious sigh, "the High Priest himself."

"Then this is it," said K'chir. He began ping-chirping an alert in all directions.

"What are you doing?"

K'chir paused his chirping to say, "Bringing out the people, at least the young people—I hope."

Jerik and K'chir floated down while drifting laterally in the current. Those below arrayed themselves in a circle and moved to keep the floaters directly above its center. The High Priest, Harshket, positioned himself at the center of the circle.

Jerik and K'chir hit the surface, bounced a few times, and then settled onto the ice. Jerik felt light, ungrounded, and insubstantial. He wished he'd had time to roll in his life-bubbles as was K'chir's plan.

The circle collapsed in on them.

As Jerik and K'chir found their footing, Harshket came up to them.

"Um..." said Jerik. "Well ... as you requested sir, we're here."

"You!" said Harshket, pointing at the Third Schooler. "You have been cast down from heaven."

"No, sir. We just fell off the wall," said Jerik. He heard a soft moan from K'chir.

"Just as I suspected," said Harshket. "You have attempted to violate the sanctity of God's domain."

Jerik hung his head. It was impossible to lie successfully to Harshket, or to any priest, trained as they were in the pursuit of truth. In the ensuing silence, Jerik heard the distant soft buzz of massive chirping; apparently K'chir had been successful in turning out the people.

"You must realize, Jerik," said Harshket in a deceptively soft voice, "how serious an offence this is against God. You must be punished for your horrid deed."

Jerik didn't answer, but K'chir did. "If he offended God, then why not leave it to God to punish him?" Jerik knew K'chir was merely trying to help, but he wished his friend had kept his silence.

"As you were not the instigator, Jerik," said Harshket, ignoring K'chir, "you will simply be beaten—and forgiven."

"Thank you, sir." Jerik hated himself for giving the required response. He felt the ripple of current as the priest turned to K'chir.

"But for you, K'chir, there is no earthly redemption."

Jerik sensed his friend go as motionless as a rock. A few of the people chirp-mapped, but mostly the water was silent—save for the constant grinding from beneath the ice.

"For the crime of sacrilege," Harshket intoned, "your life-bubbles will be beaten from your body and your body will rise to heaven. Far better that than cede your immortal soul to the Antigod."

"No!" came a voice from the people. It sounded like a student in the Fourth School.

"Life-bubbles are a gift from God!" Harshket raised his voice over the cries. "You are not worthy of them. But for your redemption, your precious life-bubbles will be your contribution to your people—allowing another of our people to be born. I and the people thank you for your sacrifice."

Angry shouts of "No" came from many youths in the crowd.

"This is an important lesson for the people," Harshket shouted over the protests. "In fact—in fact so important that the punishment and sacrifice will be administered in the presence of the Antigod himself." He paused as if for effect. "To show our contempt for him."

Like a tide, an expectant hush washed over the people, broken only by the sounds from under the ice.

"Where the hellish noise in the ice is the loudest," shouted the priest, "there, we will go to confront the God of Evil." He paused. "We are not afraid!" he intoned as a chant. He hesitated as if expecting the people to pick up the chant, but the people only ping-chirped. Then in a quiet voice Harshket said to those around him, "Attend that the malefactors do not flee."

Jerik felt himself grabbed by many limbs and propelled toward the grinding sounds. He could tell by the smells that his captors were old people. The trip to the center of the noise was a delay of his punishment, and Jerik was grateful for that. He wanted to say something comforting to K'chir but couldn't think of anything that wouldn't sound banal.

At a point where vibrations shook the ice and the din had grown to a muffled roar, Harshket called for a halt. "Here," he shouted over the subsurface rumbling, "we will display our contempt for the God of Evil." He turned to Jerik. "We'll start with you." He chirped a superior smile. "Be thankful that in your case, it will just be a beating." Clearing his voice with a grunt, he turned to K'chir. "And then we can attend to the more serious matter." Again, he addressed the people as a whole. "Let this be a lesson to our young people."

Harshket gave the order and six of the people stretched Jerik out on the ice. The ice, quivering and groaning, seemed to be foretelling Jerik's fate, and he winced in anticipation. Suddenly, he had a renegade notion: he wasn't going to just lie there and take it. He'd taken enough. He'd fight, struggle, try to break free.

But just as he began kicking, he heard a great crash. Then a turbulence in the water pulsed across his body. His legs easily broke free, or maybe were released. He scrambled to his six feet, then ping-chirped—one voice in a sea of pings—and found that something had broken through the ice. Repeatedly then, he chirp-mapped, sacrificing spatial resolution for temporal, and detected an object rising from a tumble of ice fragments. The object appeared similar to the four-footed thing that Harshket had

maintained was a demon from the Ice God. Jerik shivered. *Could The High Priest have been right?*

Jerik, chirp-mapping steadily, couldn't actually tell if the thing did indeed have four feet, for it had stopped midway in its emergence from the ice. But in any case, it was huge—far larger than the thing Harshket had observed. It was clearly a thing of design, of purpose. And it was awash in electromagnetic fields.

Jerik heard K'chir come to his side.

Suddenly the thing emitted a hissing sound, and then Jerik heard the sounds of falling bubbles and the smell of them reached his nose: life-bubbles, and they smelled pure and sweet. The hissing grew stronger and the trickle sounded now like gushing torrent. Jerik chirp-mapped faster and observed the bubbles cascading down from a crack in the object and forming an air lake around the object's base. He gasped as he understood the significance. Then he heard K'chir gasp as well.

"Observe!" K'chir shouted to the people. "If life-bubbles come only from the Great God, this device cannot be a thing of evil. It cannot be a surrogate of the Antigod."

Jerik heard chirps of agreement.

"What is its purpose, I wonder," Jerik whispered.

"Maybe," said K'chir, softly, "maybe someone from another world wants to say hello. And if it does, I certainly ... What's it doing now? It's opening up."

Jerik observed what seemed to be a thin slab of ice pivoting away. "There's some sort of a ... a cave in its side."

As Jerik chirp-mapped, a roughly spherical device of some sort emerged from within the cave. It floated upward for a time then stopped. High levels of electromagnetic radiation came from small areas of the thing.

"What's going on?" said Jerik.

"I think it may be ... observing us." K'chir scuttled up to the bigger object. "Amazing!"

"Be careful," Jerik said at a loud whisper. He chirp-mapped furiously and observed his friend wallowing in the lake of air, his leg and body fur absorbing the precious bubbles.

"This is wonderful!" K'chir called out.

Jerik detected that the people were in a frenzy of chirping, but no one said anything, not even Harshket. Jerik turned and pinged the people. *They're probably too stunned.*

Then he heard a collective gasp, staggered, of course, as each of the people observed at his own map speed. Jerik swiveled back toward the object and chirp-mapped. Then he too gasped. K'chir had leaped up from the lake and into the cave-like opening in the object.

Jerik sensed a sudden increase in the electromagnetic field around the object and he began chirp-mapping as fast as he could. He observed the slab pivoting very slowly back. "Get out, K'chir," he shouted. "Fast! The cave is closing."

"No!" K'chir shouted back. "This thing comes from another world. And I want to experience that world." He held up his two forward legs. "I will be back!"

When the slab had completely covered the cave, the thing began to rotate. A loud churning and grinding sound filled the water and the object gradually sank down into the ice. At the same time, the floating sphere rose slowly toward heaven, increasing in speed as it went.

Almost too shocked to chirp-map, Jerik listened as the sound from the ice gradually morphed to a distant rumble and then, all at once, changed to a far off whisper. Then, abruptly, the ice went silent. Jerik felt alone. His best friend was gone. Jerik ping-chirped the hole in the ice, a perfectly circular

opening, clearly not something made by nature. He chirped deep into the opening. *Empty!* Just water where ice had once been. And no ping echo came back from the hole. *A void, nothingness!*

"The Antigod has taken the heretic," came the High Priest's voice shouted from behind. "Praise God. And take you that as a lesson."

Jerik spun around. "No!" he shouted. That's a lie." He startled himself; he'd never openly contradicted an authority—especially not the High Priest. He turned back briefly and pinged the lake. "Those are life-bubbles. But they are *not* from any god."

"It is time for your beating," said Harshket, loudly and angrily.

"I will *not* be beaten," said Jerik with equal anger. He heard a chirp of support from someone he knew to be a student in the Third School. Then he heard a flurry of encouraging chirps from other Third Schoolers—and then from students in the Fourth. He felt a surge in the current as a mass of the people came toward him, chirping encouragement—just about all the school and many of the older people as well.

Then, as one, they turned on the High Priest and his cohorts.

Jerik heard Harshket's voice over the crowd. "Your beating is deferred." The priest and his allies then scuttled quickly away.

Yes, it is a lesson. Jerik greeted his friends from the Third, and then all his new friends. Finally, feeling both light-headed and light-weight, he excused himself and glided toward the Rippled Wall—to the cleft where he and K'chir had made their assault on heaven. At the base of that cleft would be his and K'chir's life-bubbles. He would absorb them, his and K'chir's alike. Jerik extended his mandible in the realization that he'd already absorbed some of K'chir's independence and maybe some of his courage as well. He pinged upward to the rising sphere, now almost at the chirp-echo limit, and thought of his friend. Jerik vowed that he'd devote himself to the struggle for change—to assure that when K'chir did return, he'd find a different and a better world.

"Damn it!" Mission specialist Paul Hopcroft let his fist fall at 0.145 Earth gravity onto his control panel. "The observation sphere. It's sinking fast. We've lost control."

"Is it still transmitting video?" Colin called from the "pool." Surface team leader Colin Shepherd darted toward Paul's display.

"The signal's fine." Paul peered at the transmission, watching as the group of craboid creatures grew distant on the screen. "Damned robot! I'll take a manned vehicle every time."

"If it weren't for the unmanned Jovian I," said Alex, the other specialist, "we wouldn't have any idea what we were doing."

Paul gave a grunt of a laugh. "You mean, we *know* what we're doing?"

Colin, looking over Paul's shoulder, stared silently at the video monitor. Alex also came to look, drawn away from his own monitor by the much more interesting view on Paul's.

The three wore EVA suits, but with their helmets off. A transparent dome provided them with air, pressure, and warmth—and light.

The great orb of Jupiter looming large in the ink-black sky filled the dome with reds and yellows and bathed the Ganymede ice field in an orange glow. A half kilometer away, the lander, their bus home, gleamed against the ice.

The research dome, some twenty meters across, functioned also as an ice-fishing tent. At its center was a two-meter-diameter hole in the ice, the work of the borer module. Near the hole, looking like a kids' aboveground swimming pool, stood the Ganymede Sub-surface Environment Chamber. A transparent cover sealed it so that the pressure and temperature beneath the ice might be replicated and preserved.

"Looks to me like organized, structured behavior," said Colin, staring at the group of craboids in the display.

"Ant colonies show that too," said Alex.

"This looks to be a much higher order," said Colin, softly. "I'd call it intelligence. In fact, I'd be tempted to call it sentience."

"Sentience?" said Alex. "Come on."

"I tend to agree," said Paul. "And their rich set of vocalizations could very well be speech."

Colin blew out a breath. "Who'd have thought the first alien intelligence we'd find would be in our own solar system?"

From the corner of his eye, Paul saw motion in Alex's display monitor. Paul turned to look—as did Alex and Colin.

"Ha!" exclaimed Colin. "The critter took the bait."

Alex shook his head, vigorously. "No. I didn't even get the chance to *release* the bait." He dashed back to his control panel and gazed at the monitor.

"I saw it," said Paul. "The craboid just jumped into the chamber."

"Hm," said Colin. "Adventurous creature, isn't he?" He turned to Alex. "Let's get him up and into the pool—that is, if we can still control the iceborer."

Alex worked a control. "Borer's fine. I'll speed it up. We should have our six-footed friend on the surface in about twenty minutes."

"Careful not to damage the borer," said Colin. "I want to be sure we can return the creature to its home."

"Not pickle it and bring it back with us?" said Alex.

"I'm assuming it is an intelligent being," said Colin with a small trace of anger.

A half hour later, the three had transferred the specimen container holding the craboid from the borer to the pool. They stood watching the creature through the pool's transparent cover. The craboid scuttled, upside-down, on the inner surface of the cover.

"Natural enough," said Paul. "Its overall density is a bit lower than that of water."

"It does look weird, though," said Alex.

Paul stared at the meter-long and about-as-wide creature with its six furry legs and fearsome head with unidentifiable organs. "It looks a lot more imposing up close, doesn't it?"

"The cameras and probes are all on, I assume," said Colin.

"Of course." Alex went to his console. "And all functioning."

"I wonder," said Paul, staring at the creature with its agile limbs, articulated nearly to the point of being tentacles, "can a sentient species exist without artifacts or opposable thumbs—or any thumbs for that matter?"

"Hard to generalize from only a single case," said Colin. "Until now, perhaps."

They gazed at the craboid in silence for a few seconds more. Then Colin said, "I'm going in."

Paul jerked around. "What? In the pool?"

"Our friend shows a spirit of adventure," said Colin. "Can I do any less?"

Alex came back to poolside. "I'm not sure that's a particularly terrific idea."

Colin shrugged. He retrieved his helmet and had Alex and Paul help him with it. Then, after check out, Colin leaped to the pool cover, an easy task in Ganymede's low gravity. He went to the access hatch.

"You're sure you want to do this?" said Paul over the radio link.

Colin gave a hint of a laugh. "I'd rather not think about it at the moment." He opened the hatch, slid into the water, and closed the hatch above him. In his EVA suit, he, like the craboid, was lighter than water. Colin lay horizontal, his stomach pressed to the inner surface of the pool cover.

"They're looking at each other," Alex whispered.

"Not exactly," said Paul. "The creature doesn't seem to have eyes. Wouldn't need them under the ice."

Paul watched as Colin slithered close to the creature. Then, slowly, very slowly, Colin held out his hand.

"Shaking hands," Alex whispered. "You think?"

Paul gasped softly as the creature extended a front leg, then touched Colin's hand.

"I'm willing to bet," Alex whispered, "that this image will be on a postage stamp next year."

Paul, mesmerized, could not pull his eyes away or even answer.

After a few seconds, Colin said a ritual greeting, loudly, so it might be heard through his helmet. The creature made some sounds as well: clickings and chirpings. Then, after another brief pause, Colin and the creature withdrew their appendages. Colin crawled backwards to the hatch.

Alex shook his head. "We're going to have one hell of a story to tell when we get back."

Paul, his eyes on the craboid, said softly, "And so will he."

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Novelette: **WILDERNESS WERE PARADISE ENOW** by H. G.
Stratmann

Decisions must be based on the best information available—which can be dicey when that information is a hodgepodge of fact and illusion.

Ah Love! could thou and I with Fate conspire

To grasp this sorry Scheme of Things entire,

Would not we shatter it to bits—and then

Re-mould it nearer to the Heart's Desire!

Edward FitzGerald, *The Rubaiyat of Omar Khayyam*

* * * *

"Do you think the aliens killed them?"

Dr. Alexander Stone, NASA's head of space medicine, didn't look at the woman questioning him. The former astronaut stared instead at the three huge screens in front of them at the Mission Control Center in Houston. He focused on the screens' words, numbers, and computer graphics showing the data feed from Zubrin Base—as if trying to use those displays like a telescope to see what was happening on Mars.

Finally the physician turned toward her and replied, "We don't know if Slayton is still alive. It's been over fourteen hours since his last message, but he didn't seem to be in immediate danger then. However, based on the last vital signs and other telemetry information he transmitted on Savitskaya's condition, my medical staff and our counterparts at the Russian Space Agency agree she must be dead by now. The injuries she sustained when the two of them explored the aliens' artifact were too severe for her to survive much longer."

Nancy Kelley, flight director for the project, sighed. "That means it's time to notify Washington and the next of kin, then face the media. Challenger, Columbia, the ISS incident—this is the type of press conference I hoped I'd never have to give. It's been nearly sixteen years since anyone's died from being in space. I know our luck had to run out sometime. But it still hurts."

The flight director briefly removed her wire-frame glasses and wiped moisture from her eyes. Though she was a decade younger than Stone, her face seemed to sag to his age and beyond as she continued, "Everybody, especially Martin and Katerina, knew this first flight to Mars was the most dangerous space mission ever attempted. The biggest wild card was what the aliens would do. After all the good they've done by terraforming Mars and moving the planet closer to the Earth, we gambled they wouldn't turn hostile once our two people landed.

"Looks like we lost our gamble."

Kelley gazed sadly at the cardiologist. "This is hard on you too. How are you holding up?"

Stone shrugged.

Kelley left to speak with several flight controllers seated at nearby consoles. Stone rubbed his palm over the back of his bristly gray hair and peered again at the silent screens. These last tense hours made him feel every second of his sixty years.

After his great failure on the International Space Station in late 2020, he'd managed to keep all the astronauts under his care safe and healthy—until now. Crews on the last missions to the ISS, later ones to its successors, and flights to the growing lunar base had experienced only minor medical problems. There'd been no serious injuries or fatalities caused by human carelessness in space—a track record he hoped was at least partly due to lessons learned from his last tragic journey into orbit nearly sixteen years ago.

And now the person whose success his well-concealed soft sentimental side cared about most was dead—killed on her thirty-third birthday. Katerina

was several months younger than Martin and only five years older than his own daughter. Stone remembered that sweet, talented cosmonaut sitting beside her fiancé in the health classes he'd given them before their trip to Mars. He'd intentionally projected himself as a stern father figure to those two young people—trying to teach them right from wrong based on his own mistakes, and keep them safe.

When the Russians discovered Katerina and Martin had become engaged and wanted to remove her from the mission, he'd talked them into keeping her. Yes, he'd honestly believed she was the best choice for this project and deserved to go to Mars. But no one else had to know that he was trying to help not just Katerina but himself too. She was his secret surrogate for another young woman he'd once known—a cosmonaut and colleague whose career and *life* he'd destroyed without wanting or meaning to. He'd been forced to choose between his responsibility as a physician to everyone who would ever travel in space and shattering only a single person's dream.

Did it hurt anyone besides him if he hoped Katerina's success might make up a little for what he'd done?

Now the cardiologist knew the answer to that question. History had repeated itself and he was responsible for destroying another life—

Stone noticed a growing commotion among the other personnel crowding the spacious control room. One screen in the front of the room showed an interference pattern that resolved into a picture transmitted from the sole human dwelling on Mars.

A video camera within the habitation module centered on a sight his training and experience as a physician refused to believe. If what he saw wasn't an antemortem recording, it was a medical miracle.

The slim attractive woman on the screen, transmitting from over twenty-five million kilometers away, had long auburn hair and hazel eyes. "Zubrin Base here. Katerina Savitskaya speaking. Martin and I are both alive. I cannot provide you now with more details about our situation. Do not, I repeat, do *not* try to contact us. I will send you an update when and if I can. End of transmission."

Stone stared at the screen where Katerina's image had just disappeared. The relief he'd felt momentarily was replaced by fear. She was alive—but based on her injuries and the limited medical care Martin could give her on Mars, she *shouldn't* be alive. Only something more than human could've healed her—and the price it demanded for doing that might be so high she'd be better off dead.

Something was very wrong on Mars—and he hoped Katerina and Martin could make it right.

Katerina stabbed a button on the communications console and ended the transmission. Her chair inside the habitation module's cramped compartment creaked as she rocked and prayed—struggling against the terrifying thoughts that tormented her. Her blue jumpsuit and black boots were caked and filthy with red Martian mud. Her whole body felt unclean.

The young cosmonaut's right hand clutched the three-barred golden cross hanging from a gold chain around her neck. She tried in vain to use this sacred symbol of her devout Russian Orthodox faith to exorcise the evil that possessed her. Attempting to free herself from the fears looping in her mind, she grabbed her music player from atop the console and fingered its click wheel. Finally she found a piece that matched her self-flagellating mood of anguished despair.

Hidden wireless speakers shook the tomb-like cabin with the Kyrie from Haydn's *Missa in Angustiis*. Katerina felt herself engulfed by shadows of D minor darkness too deep for the brightest light from heaven to dispel. The orchestra's slashing strings and solo organ's clashing chords mocked the pleas for divine mercy screamed by the chorus and soloists that echoed the ones in her own mind. Brutal fanfares by three piercing trumpets and a pair of pounding kettledrums sounded like steel-gray spikes being hammered through the outstretched limbs of the crucified Savior.

The music ended in a thundering repetition of its savage opening notes with no hint of hope or healing. Exhausted in mind and body, for now at least Katerina felt able to resist the “gift” the aliens had forced her to accept—the unwanted knowledge of how to manipulate matter, energy, gravity, and time that tempted her to be more than human. And while she possessed that

hard-won self-control, she had to confront a challenge even greater than her own death had been.

Katerina walked stiffly through the habitation module's compartments to its open exit. Her boots thudded onto the short ramp leading down from the module, a squat metal cylinder nine meters in diameter by five meters tall and supported by an array of stubby legs, to the surrounding plain. She trudged out onto reddish-orange soil still damp from a recent shower and took deep breaths of the warm oxygen-nitrogen atmosphere the aliens had bestowed on Mars over the past ten years.

The morning Sun, shining only seven million kilometers farther away than Earth's average distance from it, brightened a clear azure sky tinged with a roseate blush. Katerina fingered her golden cross and braced herself for what she had to do. She had to find the man she loved and redeem him.

And if he couldn't be saved, she had to destroy him.

* * * *

Martin Slayton stood floating a meter above the ground and laughed. The aliens were right about the gift they'd given him. *It was* easy to manipulate gravity.

He rocketed up another forty meters into the air—chuckling at the feathery tickle that ascension made in his stomach. Curling himself up as though he were about to do a cannonball dive, Martin did several slow head-first rotations in place—just as he'd done in microgravity four months ago on the Ares VII rocket traveling to Mars. Still suspended in midair, he eased himself into a prone position with arms extending straight out in front of him.

Of course, flying took more than just changing how his body was affected by the ambient $0.91\ g$ gravity the aliens had given Mars. But they'd also shown him how to manipulate matter and energy in any way he desired. He just had to provide all the molecules in his body with the right amount of energy and correct vectors to move at the same time in the direction he wanted.

As he flew in lazy circles above the Martian plain, Martin didn't care if he seemed to be violating the conservation of energy and several other laws of physics. It didn't matter that the aliens hadn't explained why he could do all these things now. The fact they'd showed him how to do them was enough. After all, he'd learned to walk as a toddler without knowing he had bones and muscles in his legs—much less how they worked. His new abilities required no more effort than moving his arm. They were as natural as speaking—as easy as thinking.

Martin zoomed farther up into the sky—arms spread outward to embrace a sun only slightly smaller and dimmer than it shone on Earth. But he stopped before rising too high—content to be Daedalus instead of Icarus. There he relaxed and enjoyed his bird's-eye view of the scenery far below.

He soared over a garden ninety meters by sixty meters that Katerina and he had planted a kilometer from the habitation module. The green bean bushes, cornstalks, and wheat growing there seemed to look up in awe at the Missouri farm boy-turned-astronaut sailing high above them. He imagined the denizens of that garden cheering him as their protector—a super scarecrow.

Martin smiled—pretending he was one of the four-color superheroes whose classic adventures he'd enjoyed reading as a boy. He pictured the maroon pullover shirt, white shorts, and ebony boots he wore, and the scarlet St. Louis Cardinals baseball cap covering his close-cropped black hair, replaced by more colorful garb. In his mind a red cape with stylized yellow “S” fluttered behind him in the Martian breeze.

Next he imagined himself donning instead a darker uniform of green, white, and black, then slipping a power ring onto the middle finger of his gloved right hand. The aliens had given him a gift that made him the most powerful man alive. All he had to do to save the world was to be honest and without fear—

His alien-enhanced vision spotted movement on the ground beneath him. Martin stopped in mid flight—scowling as the blue-clad figure walked to the edge of their garden and stood looking up at him. He glided feet-first to a soft landing five meters from where Katerina gazed at him with an

undecipherable expression. His subtle attempt to pry into her mind and read her thoughts was instantly blocked by her own alien-augmented will-power.

Locked in a silent stare with her inscrutable hazel eyes, Martin didn't feel fearless anymore.

* * * *

Katerina masked her thoughts and feelings from the stranger frowning at her. The stone face she showed this parody of the man she loved hid her fear that the Martin she knew was lost forever.

The alien body that looked like Martin sneered, "You don't have to just walk anymore."

"You said the only miracle you really wanted to do was to 'resurrect' me."

"Yes."

"But that's not all you want to do now."

"No."

Martin shook his head. "Don't you see, Katerina? We've been given an opportunity no one's ever had before. The aliens gave us the power to manipulate matter, energy, gravity, and time. I'm still experimenting to see what exactly that power lets us do—especially how we can manipulate time—but I know *how* their gift should be used. There's so much suffering, violence, disease, and death on Earth. We can use our powers to end all that misery and turn the world into a paradise!"

"Is that why you think the aliens forced us to accept their gift, Martin?"

"Heck, they're aliens! Who knows what they think or why they did it! Maybe they're trying to save humanity but have some variation of the Prime Directive that forbids them to do it directly. Maybe they believe it's okay to delegate their powers to natives like us to do the job for them. After all, we're the 'insiders.' We're in a better position than the aliens to know what's best for the human race and have the strongest motivation to help it!"

"Maybe the aliens are using us as their instruments—but not to help us. Perhaps their 'code' prohibits them from destroying us themselves. Instead, by giving us enough power they expect we'll destroy Earth or conquer it for them!"

Martin waved his hands dismissively. Then he concentrated on a patch of ochre Martian soil several meters from where they stood. The dirt swirled up in a miniature dust storm that sculpted itself and congealed into the form of a straight back chair. Martin sat down in it, still facing his fiancée.

"That's one of the oldest SF clichés around, Katerina. The first thing every mutant, member of *Homo superior*, or anyone struck by an Evolvo-Ray does is to try to conquer or crush 'normal' humans. That plot makes for exciting stories—but *I* would never do that!"

"Then why are you sitting on a throne?"

Martin stood up. He glanced back at his creation and made it crumble back into dust. "Sorry. It was supposed to be a club chair, like the one in my parents' living room."

His eyes darkened. "I hope you're not thinking about pulling an Elizabeth Dehner on me."

"You're referring to the second *Star Trek* pilot, 'Where No Man Has Gone Before.' No, I don't want to fight you, Martin."

"I'm surprised you've seen that episode. I didn't think you knew or cared much about science fiction. I usually have to sweet-talk you into watching my collection of old SF movies and TV shows with me."

"I haven't seen it—but you have. I saw your memories of it in your mind."

"So you're against me using my powers and won't let me read your thoughts—but you're perfectly willing to do it yourself! Well, do whatever you want inside my mind! Keep watching and listening to what I'm thinking! Maybe that'll convince you I won't let this power corrupt me!"

"I know you'd never intentionally hurt anyone, Martin. But although we've been given superhuman powers, our minds are still human—all too human. Even with the best intentions we could cause terrible pain and suffering because we don't know the best way to use these powers."

"But if we don't use the aliens' gift to help humanity because we're afraid we'll do the wrong thing, we'll be shirking our responsibility to help others. Better to try and fail than to not try at all!"

"The stakes are too high, Martin. Instead of saving the world we could unwittingly doom it. The powers we've been given are so great we might not be able to undo our mistakes. 'The Moving Finger writes; and, having writ, Moves on: nor—'"

Martin cut her off. "I know some quotations too—like 'With great power comes great responsibility.' It's too late, Katerina. The genie's out of the bottle. I'm ready now to let Mission Control know what's happened—unless you've already done it."

"I've only told them we're alive. Nothing more."

"I presume you used our communications console. No need for that anymore."

Martin stared up at the sky. His mind probed out from the Martian wilderness into the void—searching through space until familiar images in Houston entered his consciousness. "You should try this, Katerina. It's like watching 3-D TV. Don't ask me how, but I can even hear what they're saying—and thinking."

He smiled. "Nope. They don't have a clue at Mission Control. Hey, Dr. Stone's there too. I bet he's wondering how I cured you. Let's see what he's thinking."

Seconds later Martin's grin collapsed in embarrassment. "Who would have thought ... so much guilt over what he did..."

"So now you're using your powers to invade other peoples' private thoughts. How long will it be before you're telling them *what* to think?"

"Okay, I made a mistake. Now I know better. There are other ways to test my powers that I'm sure will help people."

Martin stroked his chin. "Maybe I should start close to home. Look in my mind and see what I do..."

* * * *

The isolated farmhouse shuddered as rain and golf ball-sized hail pelted its walls in front of an approaching tornado. From the gray night sky the thunderstorm ripped peeling paint from the dwelling's weathered wooden siding and tore shingles from its roof. Howling winds whipped the heavy limbs of the ancient oak tree in the front yard—splitting off a large branch that crashed through the home's picture window.

Amy Gale screamed as glass shattered and sprayed across the family room above her head. She sat hunched on the basement's cold concrete floor, surrounded by a thick darkness broken only by the fading flashlight beside her. Three-year-old Dottie scrunched closer and clutched her mother's blouse. The child whimpered as lightning flashed again outside the tiny basement window nearby—followed almost immediately by a thunderclap that shook the house like a miniature earthquake.

After the electricity went off thirty minutes ago, their only link to the outside world was the ancient battery-powered weather radio nearby. Its computer-synthesized male voice blandly informed them that a severe thunderstorm watch was in effect for Webster County, Missouri, until 9:30 p.m., and suggested they take shelter immediately. The voice added that conditions were right for the creation of a tornado.

Amy hugged her daughter and whispered that everything would be all right. But as the storm's fury grew she couldn't calm her own fears. She was only twenty-five—too young for the Lord to call her home. Little dark-haired, blue-eyed Dottie hadn't even begun to live. And there was no way to know whether her husband was safe. After their latest argument several hours

ago, Nick had stormed out of the house and driven off in his pickup truck. Instead of being with his family he could be anywhere on the road between here and Marshfield—perhaps lying dead in a ditch....

Close to her ear Amy heard her daughter murmur through the thunder, "Please, God, make the storm go away. Keep Mommy, Daddy, and me safe."

Neither knew that in spite of Dottie's prayer the tornado would reach them in four minutes. Winds swirling at over three hundred kilometers per hour would blast away the roof, then crumple and splinter their house into a massive pile of debris. Seconds later the floor over their heads would be ripped away and expose the pair's sheltered hiding place in the basement. Mercifully they would feel only an instant of terror before their bodies were crushed and impaled by an avalanche of wood and metal collapsing on top of them—

Suddenly a miraculous stillness settled over their home. No more flashes of lightning illuminated the basement's window. Amy listened in vain for thunder or shrieking winds. Then she heard a tiny voice snuggled near her smile three words.

"Thank you, God."

* * * *

The man who'd once been merely Martin Slayton chuckled. "See how easy it is to manipulate matter and energy, Katerina? A little change in temperature and barometric pressure, and the rain and lightning go away. Bleed off some energy from overexcited molecules in air, and no more tornado. Hurricanes, tropical storms, earthquakes, tsunamis—we could stop them all with our powers. Think of all the people we could save—the destruction we could prevent!"

"He arose and rebuked the wind and the raging of the water; and they ceased, and there came a calm.' I heard people praying to you, Martin. Do you enjoy being worshiped?"

"Nobody knows *I* saved them! It was an anonymous good deed! I'm not interested in getting thanks or glory. I don't care if they think it was a miracle!"

"Even if you don't call yourself a god or want to be one, you're still acting like a god. What are you going to do now, Martin? Are you going to continuously monitor weather throughout the world or check for every tectonic plate shift that could produce an earthquake for the rest of your life? And when do you decide to make a change? The same mild shower that gives farmers the rain they need for crops could also produce a rain-slicked highway that causes a fatal car accident!"

Katerina frowned at him. "I heard what you just thought about the 'butterfly effect.' You were remembering an old-time science fiction story and a later analogy based on chaos theory—that the flapping of a butterfly's wings in Brazil could produce tiny changes in atmospheric conditions in a ripple effect that eventually causes a tornado in Texas. You saved lives *now* by stopping that particular tornado, Martin. But how do you know you haven't inadvertently doomed many more people in the future?"

"Next you'll be telling me that one little girl I saved will grow up to be a ruthless dictator—and that by keeping her from dying today more people will die years from now. No, Katerina, the aliens didn't give us the ability to predict the future. But by that same logic no one would be able to do *anything* for fear it might have unintended bad consequences.

"According to you, no doctor should cure a dying child because she doesn't know what kind of adult that child will become. Nobody should have children at all because none of us knows how they'll turn out! Police, firefighters, and paramedics shouldn't save anybody who's in danger because they don't know what kind of life the victim they help will lead afterwards! At least I'm *trying* to help people. You want to be the Angel of Death!"

"When you make changes this great, Martin—far beyond what the person you *used* to be could do—the consequences of your actions are equally great for good *or* bad. The aliens' 'gift' has brought you closer to being omnipotent than any human being has ever been. You may rival God now in

that one attribute—but not others. You're not all-wise, you're not all-knowing, you're not eternal, you're not—"

Marvin interrupted her contemptuously. "You want us to be like cattle and sheep—passive playthings in the hands of God, Fate, or whatever—afraid to do anything because we *might* make a mistake! I believe we should do what seems right today and deal with the future when it comes. I wonder how many people have died while we've been arguing about this—people we could've saved! If you won't help me, I'll do it myself—"

* * * *

The hospital room where Manuel Cruz lay dying had smiling teddy bears and rainbow-striped dinosaurs painted on its walls. Dolores Cruz sat beside her nine-year-old son's bed, holding his feverish hand. The boy seemed to be sleeping, his breaths coming in gasps through the clear plastic oxygen mask covering his lower face. The beeping from the heart monitor above his head and hiss of the blood pressure cuff periodically inflating and deflating around his wasted arm were the only other sounds she heard.

The nurses who wafted in and out of the room glanced at her sympathetically. Like her, each one was swathed in a yellow paper gown—hands encased in latex gloves, hair hidden beneath an azure surgical cap, mouth and nose covered by a mask. Dolores knew these "reverse isolation" measures wouldn't help her son anymore. But they made it easier for the professionals caring for Manuel in his final illness to fuss over his IV fluids and do their other work without lingering with her any longer than necessary. They didn't want to give her false hope or admit the truth any more than she wanted to hear it.

Dolores's glove wiped away tears. She and Carlos knew this day might come when they adopted Manuel at six months old. Both were in their late thirties and successful lawyers when they'd married. The fertility clinic they'd visited after failing to start a family had done everything medically possible to help. But after yet another miscarriage, she and her husband had decided on another option.

They could've adopted a "perfect" baby—not one innocently suffering from the sins of his drug-addicted, HIV-positive biological mother. But here was a baby that needed even more love than usual—and she and her husband had more than the usual to give. The doctors said the latest medications could suppress development of AIDS for years—and despite all those decades of setbacks there was hope that a cure might be discovered soon.

But time had run out for Manuel. His immune system had collapsed with that elusive cure no closer than when he'd been born. For the last two years he'd spent more days inside than out of the hospital—suffering from vomiting, diarrhea, and infections. Nutritional supplements, then a thin feeding tube passed through his nose and down into his stomach, and finally "central hyperalimentation" IV fluids hadn't prevented her son from wasting away to a skeleton covered by a layer of dry skin.

Manuel had been too sick in the hospital to even go to the funeral when his father died of a heart attack two months ago. Still reeling from that loss, Dolores knew that soon she would lose the other person she loved most. Her son no longer responded to the best treatments the doctors had for this latest recurrence of *Pneumocystis jirovecii* pneumonia. Their medicines kept him from suffering too much. But there was nothing they could do to ease the ache in her heart.

Her vision blurred—imagining what her son would look like if he were well. She saw his sunken cheeks plump with health—his arms strong enough to give her a loving hug. Exhausted from grief and worry as evening turned into night, her head nodded for a few moments of soothing sleep....

Dolores jerked awake when a gentle hand touched her cheek. A startled cry escaped her throat as she saw a stranger sitting in her son's sickbed. She blinked and tried telling herself she was dreaming—but she wasn't.

The boy's hospital gown was too small for his filled-out healthy frame. He removed the oxygen mask with muscular fingers, a puzzled expression on his robust face. Then he spoke in a voice she couldn't mistake for anyone else's.

"Mom, why are you crying?"

* * * *

Stone sat in Mission Control and watched a small television screen near his elbow. CNN showed Kelley giving a press conference updating what they knew—or rather, *didn't* know—was happening on Mars.

He glanced at his wristwatch: 11:38 p.m. That meant he'd been here for eighteen hours—a typical work shift for a cardiologist. More importantly, it meant relatively few people—at least in the U.S.—were awake and watching Kelley evade questions about what the media dubbed the “Great Martian Mystery.”

As reporters grilled the flight director for answers neither she nor anyone else on Earth had, Stone focused on the news items scrolling across the bottom of the TV screen. Some of them read like headlines on a checkout line tabloid. Eyewitness accounts of tornadoes and hurricanes being snuffed out could be attributed to overwrought imaginations or freak meteorological conditions.

But those reports coming from a growing list of reputable hospitals and clinics worldwide couldn't be dismissed. According to the TV, people on the brink of death were being inexplicably cured. Those with end-stage AIDS, cancer, heart disease, and other serious diseases were now completely healthy. Nursing home residents with Alzheimer's or old strokes were suddenly as mentally sharp and neurologically sound as they'd ever been. Amputees grew back new limbs and paraplegics walked. The blind now saw and the deaf could hear.

The physician grunted. If those stories were true, he might have to retrain in another profession—hopefully one with better hours....

Suddenly he realized there might be a connection between what Kelley was saying and these other events. If the aliens had healed Katerina they must also be responsible for those other cures. He wondered when someone else would think of that too.

Stone hoped that wouldn't happen soon. For it wouldn't take the public long to realize that a world in which miracles were routine might also be ripe for an apocalypse.

* * * *

"Not bad for somebody who barely passed college biology."

Martin's voice had a taunting edge. "I didn't even have to know any fine details about human anatomy or physiology to do it. All I did was will all those cures and healings in general terms—and they happened!"

"Young man, I say to thee, arise.' Are you enjoying playing God, Martin?"

"I keep telling you, this isn't about me! It's about correcting the mistake the God *you* believe in made by allowing all this pain and suffering!"

Martin folded his arms. "Of course, the aliens gave you the same power over matter, energy, gravity, and time that I have. You could reverse everything I just did. But if you make those children sick again or let people die, don't tell me it's for their own good!"

"I don't deny that what you did is good—today. But what about tomorrow? You didn't cure every person in the world. How do you think those you *didn't* help will feel? Even as we're talking more people are getting sick and being injured. Are you going to prevent or treat *every* illness and accident from now on?"

Martin scowled. "Even if I can't help everybody, helping *some* people is better than helping none at all! I intentionally didn't do some things I could've done, like making the elderly young again. I'm not sure yet that would be a good thing in the long run because of all the social and economic disruptions it could produce. So—responsible person that I am—I'll wait to do it until I figure out how to minimize any problems it might cause."

"You may already have done more damage than you realize, Martin. Besides being grateful for them, how *else* do you think people will react to

these 'miracles' you performed? Will they live more carelessly—expecting that any damage they do to themselves or others will be healed by another of your miracles? Will it discourage researchers and doctors to find new treatments that, though not as perfect as yours, rely on what's possible by human effort and don't depend on your godlike whim? Are you ready to let all of Earth's people transfer responsibility for their welfare from themselves and place it on *your* shoulders?"

"No, I can't do everything. I won't be like the robots in 'With Folded Hands.' I'm going to leave people who can help themselves alone and let them succeed or fail on their own. But there are many others who through no fault of their own don't have the ability to help themselves. And I know how to start..."

It was already hot as the Sun crept above the horizon. Far too little rain had fallen on this region of sub-Saharan Africa for months. Parched grasslands and cracked powdery soil baked beneath a cloudless sky as the inhabitants of the village stirred. In one of the mud huts thirty-three-year-old Nehanda was already awake and dressed. Though she didn't know why, she felt stronger than ever.

In the dim sunshine filtering through the shack's sole doorless entrance, even her four surviving children, ages two through seven, looked better than they had for days. Last night Nehanda feared the youngest child, her bloated belly and wasted limbs a stark reflection of how severe the drought and famine were, would be ready to be buried this morning next to her father and two siblings. But now the little girl looked healthy—as if the tiny ration of food she shared with the rest of her family really was enough to keep her alive.

But it was useless to be thankful for even the rare good things in their lives. Maybe the soldiers would come back today and leave more death and tears behind. Perhaps the village's only well would run dry and add the pangs of thirst to the rumbling in their empty stomachs. The small plots of maize, wheat, and other crops worked and shared by her neighbors and her, now coming to final ripening, might've been picked clean by birds during the night.

As Nehanda walked outside her hut several other women nodded to her. They all trod silently toward where they hoped their next meal still lay. Nehanda's face fell as she saw how little there was to gather. The shriveled stalks of grain lay flat and lifeless. Her family's share of this meager harvest, ground and baked into coarse bread, would be enough for only several mouthfuls apiece. But it would be enough to keep them alive one more day—and that was all she could hope for.

As Nehanda bent over within one of those plots, a shadow fell across the land. She looked up—and the few dry stalks in her hands fluttered to the ground. Her voice joined the cries of amazement shouted by the other women.

Enormous dark clouds gathered above their heads at a speed so fast they seemed like racing animals. Seconds later a gentle sheet of rain bathed the village in a soothing shower. For the first time in ages Nehanda laughed. She let the cool droplets dance on her tongue, then cupped her hands and rubbed the tiny pools of moisture across her chest.

Something tickled her bare legs. She peered down—and gasped. All around her and throughout the other small fields, wheat and other crops were springing up from the ground at an impossible pace. What normally took months of slow germination and growth was happening in moments. Soon she was surrounded by a lush harvest that would keep her children and everyone else fed for months.

There was no explanation for this miracle. There was no need for one. It was enough that it was.

* * * *

"If I heal the sick, I also need to keep them healthy."

Martin walked under a noontime Sun into the nearby garden. He fingered a cornstalk's leaf approvingly. "I grew up on a farm and know what crops need. And it sure helps to be able now to accelerate their growth by a factor of thousands. No one needs to go hungry anymore!"

Katerina said nothing. Inside Martin's mind she saw millions of people—suffering through no fault of their own—rescued from the brink of starvation and death. They laughed and rejoiced—grateful to be spared the agony of watching their loved ones sicken and perish, then dying themselves.

For the first time since she and Martin had been transformed into something more than human, she doubted herself. She wondered if the role she'd assumed as devil's advocate to Martin's plans might be literally true. Perhaps great power didn't corrupt *all* the time. Katerina thought of the kings and queens, emperors and czars, dictators and presidents she'd read about. Some were sadistic butchers. Many were mixtures of good and evil. Others had honestly tried to help people but lacked the wisdom to do lasting good.

But she wondered if even the rare paragons of self-control and service to their citizens like Marcus Aurelius or George Washington would've been corrupted too if they'd acquired as much power as she and Martin now possessed. There was probably a good reason no actual *saints* she could think of had possessed any personal power except their own words and example. Even Tomas de Torquemada was said to be honest and pious in his private life. Yet when given absolute power, he saw no contradiction to defending the Gospel's message of love and forgiveness with torture and murder as fifteenth-century Spain's first Grand Inquisitor.

Katerina scanned her memories of all the great works of philosophy, religion, and literature she'd read—seeking guidance on what she should do. As ideas percolated through her brain, passages in Plato's *Republic* converged with plots from science fiction movies Martin showed her on the flight here. There *was* a way to persuade him to stop using his power—but it meant she had to use hers.

She wrestled with her conscience before deciding there was no other choice. Besides, Martin told her she could do whatever she wanted inside his mind....

"Remember, Martin—'Man does not live by bread alone.' Those people you fed today will be hungry again tomorrow. What will you do then?"

Martin exited the garden and walked close to her. "I don't need to help people who can already help themselves. I'll confine my miracles to areas where they can't grow enough food to live."

"What if the problem isn't caused by Nature? What will you do if someone comes to steal that food you gave them—or uses violence against them?"

"That's a job for governments and police. And yes, I know those systems sometimes fail or can be part of the problem. But if no one else can stop violence, I'll help the innocent."

"And are you willing to use force, Martin—even kill—to prevent killing? With your power you could be judge, jury, and executioner for every criminal or anyone you deem 'evil'—and no one could stop you. They wouldn't even know you were the one who did it!"

"You know me better than that! I'd never use my power to deliberately hurt anyone!"

"But you could do it unintentionally. What if you lost your temper—or even just *dreamed* about hurting people?"

Martin grinned. "I've seen and read enough SF to anticipate anything that could go wrong. I'll be a well-behaved Star Child—and I've watched *Forbidden Planet* umpteen times. I'll will my power to not work while I'm asleep. That way there'll be no Monster from the Id—and I won't inadvertently change someone who wants to fly into a seagull like in an old Green Lantern story!"

"You're underestimating the danger. Even if you control yourself, you'll still be like one of Plato's guardians—the ultimate arbiter of what people can do or not do. But who will guard *you*?"

Martin frowned. "I'll guard myself. And I don't have to stop force with greater force. You've made me think of a better way to stop violence. Let me show you..."

* * * *

Rustam Shahidi's sweaty palms clutched the steering wheel of his pickup truck. Sitting alone in its cab, he tried to look inconspicuous as his vehicle moved cautiously through the streets of Tehran.

Along the avenue vendors offered their wares to hundreds of shoppers in this large outdoor market on a sunny Sunday morning. Rustam's dilapidated truck, stuffed with lettuce and other produce along its metal bed and wooden sides, blended in well with similarly laden ones. But none of them carried the deadly cargo hidden within his vehicle.

The young man tried not to think about what would happen to him in several minutes when he arrived at his target. There'd be a dozen soldiers around the checkpoint his truck was approaching. A simple calculation of the number of enemy lives lost compared to his meant his martyrdom would be worthwhile.

He eased the truck behind a small green car that formed the end of a short queue of vehicles stopped at the checkpoint. As the line in front of him gradually shortened, he jerked—startled by the face staring back at him from outside the open driver's-side window.

The boy smiling at him was about ten years old. Rustam nodded back—squelching an urge to whisper to the youngster to run away. The bomb in his vehicle would produce a blast radius of around a hundred meters. He prayed that the boy and other innocents would be far enough away to survive. But if they didn't, they would join him in paradise.

At least he hoped there was such a place for all of them. As these last seconds of his life ticked away, doubts about the supernatural significance of what he was about to do crept back into his mind. But even if the sum of his sacrifice was only a blow against those who repressed his country's people, it was enough to justify his death.

Rustam lost sight of the boy as his truck crept forward. There were only three more vehicles in front of where the soldiers checked a frightened driver's papers. He was close enough now that a press of the button near his hand would make his mission a success. Before any more doubts or regrets entered his brain he reached for the detonator—

The uniformed man walked cautiously toward the stalled produce truck, slipping his rifle off his shoulder into a ready position. Instead of advancing when the vehicles in front of it had moved past the checkpoint, this one sat in the street frozen in place. In the tense atmosphere that now blanketed Tehran, anything that looked even remotely suspicious could be the harbinger of sudden explosive death.

Heart pounding—terrified the next instant could be his last—the soldier crept close enough to the open window beside the driver to hear what the young man behind the wheel was muttering.

"It's wrong to kill. I shouldn't detonate the bomb. It's wrong to kill. I shouldn't det—"

That mantra was silenced by the sharp *crack!* of bullets from the sergeant's rifle tearing through Rustam's head. Gun smoke filled the soldier's nostrils as he lowered the rifle. He called back to the privates who'd started toward him to contact the bomb disposal team. Then—trying to exude nonchalance instead of the nervous relief he felt—he sauntered back to the checkpoint. By the time he reached it, he was already wondering if his deed might earn him a medal.

In this fifth year of the bloody Iranian civil war, Sgt. Bahram Bayat of the Revolutionary Guards had single-handedly stopped a suicide bomber. The government whose nearly sixty-year-old grip on power was weakening from a violent homegrown rebellion needed every hero it could find.

* * * *

Though it'd been many hours since he'd slept, fear kept Stone alert and focused on the TV screen. Several of his colleagues had wandered from their posts to look over his shoulder or at other small television monitors scattered around Mission Control.

Every screen showed nonplussed newscasters and reporters relating a burgeoning series of bizarre events around the world. Police stations were jammed with people turning themselves in for every violent crime and act they'd committed. Bank robbers laid down the pistols they were aiming at

tellers and surrendered. Child molesters, individuals guilty of domestic violence, and rapists tearfully begged to be put in jail. Criminals ranging from street thugs to the top bosses of organized crime demanded punishment for the injuries and deaths they'd inflicted. Those ranks also included an alarming number of "respectable" citizens confessing to heinous deeds no one had ever suspected them of doing.

Stone shuddered. It was as if millions of people with a sick or nonexistent conscience had suddenly been healed. But his career as a physician had taught him many uncomfortable truths. One was that a person's basic personality and actions weren't improved without great effort—and only then if the individual cooperated. Another was that no medicine or treatment was risk-free and worked all the time.

He wondered what side effects this particular "cure" might have.

* * * *

Martin floated upright five meters above the ground and smiled. Waves of contentment rippled through his mind as he sensed images and thoughts from Mission Control and all across Earth.

A voice from below interrupted his reverie. "So that's your solution to violence. You're going to control people like puppets and destroy their free will!"

"No one has a right to 'freely' hurt another person, Katerina. All I'm doing is implanting feelings and ideas in peoples' minds that should've been there all along. Things like empathy and remorse."

"And love? Are you going to *make* people care about each other?"

"No. I'm just giving them the chance to love others. Whether they choose to do that is still up to them."

"But it's just as important that they *choose* not to hate or hurt others!"

Katerina glared up at him. "You're not treating those people like human beings. To you they're just wild animals that need to be tamed. Even if it isn't the physical type, *you're* using force on them!"

"But I'm using gentle force—in a good cause. The people I've changed deliberately threatened, injured, or murdered others. The only way police can deal with criminals and killers is with the same weapons the bad guys use.

"What I'm doing is more benign. It's like a surgeon operating on someone with a brain tumor. My treatment causes less pain to sick patients and heals them better than a doctor could—"

Martin flinched as an unexpected power seized his body and dragged it to the ground. As his boots settled back onto the paprika-colored soil he laughed. "Good. I finally got you riled enough to use your own power. Maybe now you'll understand how easy it is to use."

"No. I just want you to look into my face when I talk to you."

Katerina walked closer to him. "Don't compare yourself to a doctor, Martin. Unless someone is mentally incapable of making a decision, a physician can't treat a patient without that person's consent. *You* didn't ask those people you changed if they wanted to be treated or not. And even if you did and they refused, you would've altered their minds anyway!"

She scowled. "Have you ever read Dostoevsky's *The Brothers Karamazov*?"

"Tried to read it. Never finished it. Long meandering novels make me fall asleep. Besides, what does that have to do with—"

"If you'd read it, Martin, you'd know you should be comparing yourself to Grand Inquisitors. *They* thought they were doing good by protecting their flock from dangerous ideas. *They* thought they were being merciful to heretics and unbelievers by trying to save their victims' immortal souls—even if it meant rending their bodies with the rack and wheel or burning them at the stake!"

"The method you're using is more subtle but ultimately just as corrupt. You're imposing your own orthodoxy of action—*making* people be 'good' instead of *choosing* to love and care for others. Yes, I know your intentions are good. But even the most caring, well-intentioned, and wise Grand Inquisitor is still a Grand Inquisitor. And you're infinitely more powerful and dangerous than any of them ever was!"

Martin snapped, "You sound like the Jesuits who taught me at the university. I regurgitated enough of what they said on tests to pass the theology courses I had to take. But they couldn't make me believe what they said."

Katerina took hold of the golden cross hanging from her neck. "Maybe those priests asked you this question. After being taunted, tortured, and crucified, why didn't the Savior come down from the cross and show the whole world who He really was?"

"Well, we both know the obvious answer!"

"Of course, Martin. *If* He were only a human being whose goodness inspired His followers to make Him into God, He didn't do it because He couldn't do it. But just assume for a moment that He really was both human and divine.

"If so, why did He choose to 'only' die and rise again instead of stopping His execution and creating a paradise on Earth? Like you, He could heal the sick, feed the hungry, and inspire sinners to repent. *I* think the reason He didn't stay to miraculously eliminate all evil and suffering is that He wanted *us*—humanity itself—to do it! He became weak to show us how we could become strong!"

Katerina's hazel eyes softened. "None of us will ever be perfect or without pain. Though we delay it for as long as the Old Testament patriarchs are said to have lived, we all eventually die. But whatever measure of paradise we create on Earth, Mars, or other worlds will be one we *earned*—not something given as a 'gift.' If we make life better it'll be because we used science to make Nature less dangerous and relieve human suffering. If we choose to be kind and care about others, we can claim credit for doing it.

"He showed us what we could do with our own human abilities. It's up to us to freely accept His challenge and imitate Him."

Martin grunted. "Are you finished? I was afraid you were going to make a speech longer than John Galt's in *Atlas Shrugged*. I admit you can weave a pretty bouquet of ivory tower ideas together like a Jesuit. But even the nicest words can only accomplish so much. What I'm doing is actually helping people and not just making rhetorical noise!"

"Is it, Martin? Maybe you're right that I should use my own power more. So far I've just been inside your mind seeing what you've done to Earth. Let's both go there to see *everything* you've done."

"Challenge accepted!"

* * * *

Katerina closed her eyes and extended her consciousness outward. She sensed Martin's mind accompanying her as she seemed to float up through the inverted bowl above them and move sunward through space.

Then a cacophony of sights and sounds on faraway Earth flooded Katerina's brain. With a neurosurgeon's finesse she separated images and sounds, thoughts and emotions like threads in the intricate tapestry of humanity's entire experience. Instantly she absorbed countless stories of terror turned to joy, suffering changed to health, and hunger relieved. Based on what she sensed and felt across the continents, Martin's actions had indeed brought justice to the innocent and guilty.

But like sunspots scattered across Sol's face, the young cosmonaut also found instances of pain and savagery caused by the changes he'd thrust on unwilling hearts. Some of those whose sinful deeds he'd laid bare or stopped were now battered and bleeding—others killed by those they'd threatened or hurt. Whether those people had truly received justice or greater punishment than they deserved was now moot.

Katerina's attention returned to her fellow watcher standing nearby. The stunned look on his face showed he too had seen the horrors he'd caused.

"Are you proud of *everything* you've done, Martin?"

"What I did wasn't enough to prevent violence. I thought it was enough to begin by stopping people who'd committed or were about to commit the worst kinds of crimes. I should've known those I affected weren't the only ones capable of hatred and murder."

"That's because it's easier to hate than to love—to seek revenge than to forgive. Do you think you can change human nature, Martin?"

"I can try!"

* * * *

Lieutenant Sergei Kijé shivered as his boots trudged across the frigid ground. He stopped and placed both hands in the pockets of his brown army jacket, then glanced up at a slate-colored afternoon sky promising snow soon. Behind him voices murmured from the two parked open-backed troop transport trucks where the twenty men he commanded sat bunched together. His soldiers, rifles slung carelessly over their shoulders, were trying to keep warm by bragging about their latest exploits on leave. Those inflated accounts of how much vodka they'd drunk and how many women they'd satisfied helped relieve their boredom.

The young lieutenant raised the image-stabilized high-power binoculars suspended from his neck and peered at the border three kilometers away. After studying the empty landscape he lowered the binoculars and sighed. It was rare for anything to actually happen on one of these routine patrols. He hoped the negotiations between his government and the Chinese were going well today. If they didn't, Moscow might send orders for another token incident. Perhaps a quick incursion of his soldiers across the border, or a barrage of artillery to make craters on the foreign land to the south—just enough to let the other side know that their northern neighbor was displeased.

A faint whistling crescendoed into a terrifying shriek. Three hundred meters to his right a geyser of soil erupted as the mortar shell hit. His men leapt out of the trucks, scattering and stretching prone along the ground. The

lieutenant unsnapped a transceiver from his belt and tried to contact field headquarters for orders. Hopefully they'd be told to retreat instead of retaliate—

He winced as another blast rocked the earth two hundred meters to his left. The fact only one mortar seemed to be firing instead of multiple weapons blanketing them implied the Chinese weren't very motivated to wipe them out. They might not even know his troops were here and were just creating a token political incident of their own. But an unintentionally lucky shot would be just as deadly to him and his men as a deliberate one.

A deafening third explosion close behind him drowned out the reply spluttering from the transceiver. He sent a signal back to repeat that message and groaned when he heard it. His men cursed when they heard their orders. They rapidly removed their long-range mortars from the back of the trucks and started setting up to return fire.

As he supervised their work Sergei prayed that today wouldn't be the start of a real war—and that he and his contingent wouldn't be its first casualties. In the lull following that third explosion the lieutenant listened for the screaming descent of a final shell aimed directly at him. But his men's weapons were ready before it came. Though they'd be firing blind, at least they'd let the other side know he and his troops weren't defenseless. Unfortunately it'd also let the Chinese know they had a living target—

But as he started to give the order to return fire, he stopped. Sergei and his men stood frozen—their minds seized by an overpowering force. Thoughts not their own repeated in their brains like the incessant rumble of a distant drum. The same command pressed down on each man's consciousness—trying to crush his will.

Violence is wrong. War is wrong. You must not hurt others.

A great silence engulfed the whole Earth. On every continent each human being ceased moving and heard that command in his or her own language. Every heart and soul reverberated with that same overwhelming decree. For a few seconds over eight billion people lived without hatred or brutality in a world where only peace reigned.

And then humanity began to destroy itself.

* * * *

Two minutes before the global apocalypse started, Stone woke from a catnap and refocused on the TV screen. A news commentator was describing the public's muted reaction to the day's "miraculous" events. Comparing it to the panic that raged when Mars and Venus began inexplicably moving closer to Earth a decade ago, she suggested people might still be too emotionally exhausted from that previous crisis and the reported existence of aliens to react as violently this time.

Stone groaned. It was more likely people were in denial and suppressing their fears than that they'd been desensitized to this new uncertainty. At least the newswoman didn't make a direct connection between the aliens and what was happening now. That idea might still be the spark to make the public's pent-up terrors explode once again—

The physician's mouth froze in the middle of a yawn. Suddenly his thoughts, feelings, and consciousness were seized by a power and will not his own. It felt like his brain had been plunged into an ice-cold ocean and strong unseen hands were holding his head beneath the surface. Sweat leached from his forehead and he gasped through the terrified pounding of his heart.

A sense of impending doom seized Stone as he struggled to thrust off the vise squeezing his mind. He barely sensed the words about violence being wrong thundering within his head as he fought to retain his own identity. Something *alien* was stripping and peeling his very reason away like a flaying knife. The sickening dread of what madness might be left behind after that unknown force finished its work made him fight ever more fiercely for the release of freedom—or death.

Stone dimly heard the muffled whimpers and shrieks of everyone around him at Mission Control. Suddenly, as if a ticking bomb planted in his head exploded, an exhilarating howl burst from his lips. For an instant he felt only relief—freed at last from whatever parasite had invaded his brain.

Then the shredded debris of what had been his personality and self-control scattered like dust in a tornado—never to return again.

With an agony beyond human endurance Stone's mind caved in—crushing his finely structured ego. Defenseless now against his own inner demons, he plummeted screaming into the hell he'd created for himself...

* * * *

For the first few of the handful of seconds Martin thought it would take to rid humanity of its own evil, everything went well. Then the smugness on his face faded. The corners of his lips drooped as he felt the inexorably growing reaction to the mental ultimatum he'd delivered to the whole human race. The stunned surprise he'd sensed in all those individual brains when he'd first linked with them unraveled into countless threads of fear, anger, and hatred. He'd seized the minds of over eight billion people and pulled them in the direction he wanted—but now they were pulling away from him—fighting back and attacking him!

Martin's face tensed from an agonizing effort that consumed every bit of his energy and power. His body stiffened as his mental tug-of-war with his fellow humans settled into an unstable stalemate. Standing dumbstruck on the Martian plain, he was assaulted by a combined consciousness far stronger than its individual members. Though each mind was only a spark compared to the stellar radiance of his own, focused together with laser precision at the source of their pain they formed a raging conflagration.

He clenched his fists and tried desperately to end the titanic struggle he'd started. For a moment the tiny corner of his mind still reserved for thought considered giving up. If humanity was too afraid or perverse to be changed—if all those people couldn't understand that eliminating their capacity for violence was for their own good—then they deserved the world they lived in!

But then Martin remembered all the crimes, wars, and other injustices that claimed so many innocent victims in the past and present. If he didn't use the aliens' gift—if he didn't stop that sordid history from perpetually

repeating itself or ending in humanity's self-inflicted extinction—who would?

As his mind wrestled with the unwilling ones of an entire world, Martin sensed another presence standing silently nearby. He felt that other enhanced consciousness inside his brain passively observing—like someone watching a movie—the life-and-death conflict being played out on two planets. *She* held the balance of power to end this war—and surely the woman he loved wouldn't desert him when he and the entire human race needed her most!

He barely had enough strength to speak. "Help me, Katerina! I can't control them on my own! If you add your power to mine we'll beat them and make them give up violence forever!"

Martin saw her nod.

"Yes, Martin. I'll help you."

He started to smile—and then a blinding light like a supernova seared through his brain. For an instant the rage of an entire world flooded his defenseless mind. A jet-black emptiness swallowed him as his body fell limply to the ground....

* * * *

Millions of people died during the moments Martin waged a one-man war against human nature. Airplane pilots in flight, drivers racing on busy highways, firefighters rescuing people in burning buildings, surgeons performing operations all found their minds ripped away from their surroundings. Those whose bodies were suddenly crushed in coffins of speeding metal never felt the impact. Others, standing paralyzed while individuals they'd been trying to help died, didn't notice their loss.

Then the great force clamping humanity in its unwanted grasp suddenly disappeared. Released from its chains, the human race found itself free again. But that freedom came at a terrible price.

Some, mainly babies and children, lay quiet and catatonic—their minds emptied of any volition or will. The power they'd experienced had rendered them incapable of hurting others. It also destroyed their fragile developing personalities and rendered their minds forever *tabula rasa*. Only their most primitive neurological functions remained.

Others weren't as fortunate. The struggle against the power gripping their minds demolished the well-constructed psychological defense mechanisms they'd constructed to protect their sanity. Now all the fears, anxieties, and regrets buried within their psyches and memories erupted like molten lava—searing away every other thought and feeling. Immersed in guilt, self-pity, terror, and grief, some sat perpetually weeping and screaming—trapped forever in a cocoon of pain.

The stronger-willed chose more directly self-destructive paths. Across the world, people jumped from bridges and tall buildings. Some used knives and guns to end their lives. Fire and water snuffed out the existence of still more.

But for others that abrupt removal of inhibitions shielding them from their true nature or curbing their worst instincts led to destruction and death on a global scale.

* * * *

Sgt. Bahram Bayat shuddered as his mind broke free of the power trying to bind it. He focused again on the crowded Tehran street and found new targets for the rage boiling within him, incited by that nearly successful attempt to enslave his very being. The fear and disgust he felt toward the civilians standing nearby, waking from their own mental struggle, swelled to a murderous level.

Several young men near him suddenly went berserk. They ran toward him screaming curses and threats. But just before their fists reached him, a burst from his AK-47 left the men bleeding and writhing on the ground. Bahram laughed as he emptied his rifle into them until their punctured corpses stopped jerking.

As he reloaded, he ordered his fellow soldiers at the checkpoint to join him. More rifles sprayed bullets into the mostly unresisting crowd. As the sergeant and his men concentrated on mowing down women, children, and any other civilians in range they didn't notice one man slip into the parked truck close to them. The man searched beside the driver slumped dead at the wheel, found the detonator button, and pushed it—

The explosion shattered windows over a block away. A blasted smoking crater, masses of debris, and shredded body parts marked where the truck had sat. Sgt. Bahram Bayat, his soldiers, and more than a hundred other people no longer existed. Most of the wounded farther from ground zero soon joined them in death.

But the casualties on that single street were trivial compared to the millions injured and dying elsewhere.

* * * *

In eastern Russia the force enslaving the minds of Lt. Kijé and his men disappeared. They staggered—shaken out of the stupor that had suddenly seized them. Then a savage hatred devoid of thought erupted within them. The men quickly obeyed their commanding officer's order to launch the mortar barrage they'd prepared.

As the projectiles whistled toward their distant targets, the soldiers gleefully followed their next order to pile back into the trucks and drive south. As they crossed the border into China, each man readied his rifle and hoped the enemy was near. The vision of their bullets ripping through the bodies of those who'd attacked them drove them wild with pleasure. There was no fear within them—only a white-hot obsession to kill without mercy.

Bouncing along the scrubby terrain toward their destiny, they would've rejoiced over what their superiors in Moscow were doing at that moment. The nation's top political and military leaders felt the same berserk bloodlust possessing the occupants of the two trucks now invading the enemy's homeland. Top-secret orders and codes spread throughout Russia's military network. Bombers scrambled into the air and missile silos opened.

Unaware of the massive attack being readied, the lieutenant sat in the cab of one of the two trucks and scanned the horizon for movement. He barely noticed when the other truck, driving several hundred meters in front of him, hit a land mine. By the time his truck reached the site his driver managed to swerve around most of the wreckage and ruptured corpses scattered across the plain.

By luck their remaining truck avoided running over a mine. The lieutenant gritted his teeth as he saw several heads bob above a trench half a kilometer ahead. He unholstered his automatic and prepared to bark an order to halt—

He never gave that order. Two rocket-propelled grenades hit the front of the truck and turned it into a fireball of shrapnel and flying chunks of uniformed bodies. But the half-dozen Chinese troops who'd repelled this initial enemy thrust into their country had little time to celebrate. An hour later the first of hundreds of nuclear bombs and missiles rained down on China's population centers and military installations.

Even as Beijing, Shanghai, and other cities with their millions of inhabitants vanished beneath mushroom clouds, an equally massive retaliatory strike was on its way toward Russia. Within several hours Moscow, St. Petersburg, and other former names on the map were graveyards of radioactive rubble.

Smaller nuclear exchanges across the Indian-Pakistani border and in the Middle East killed more millions. Other millions farther away from those firestorms were sentenced to die in hours, days, or weeks from injuries or radiation exposure. Over the next months billions were destined to perish from disease and starvation as the Northern Hemisphere's late calendar winter changed into a nuclear one covering the entire globe.

In areas yet untouched by atomic catastrophe, millions used fists and whatever weapons they could find against family, neighbors, and strangers. Wherever there'd been suppressed resentment and anger against individuals, races, or religions, people divided into passive or unwilling victims and murderers. Explosions, gunfire, and screams deafened the world.

Meanwhile, a great stillness reigned on Mars.

* * * *

The Sun was settling toward the western horizon when Katerina awoke after what seemed hours later. Her head pounded and eyes throbbed as she sat up. She flicked dusty auburn hair back over her shoulders and squinted up at the empty sky.

As her vision cleared, Katerina struggled to retrieve her last memory. She'd been waiting for the right time to use the full power the aliens had forced on her, and when it came she—

The young cosmonaut rose awkwardly to her feet. A crumpled figure dressed in red, white, and black lay motionless on its back several meters away. Her heart raced as she stumbled toward the spot where Martin's body sprawled in the orange dirt. His glassy gaze seemed to be looking up at circling Martian buzzards beginning their descent.

"Martin! Are you all right?"

There was no reply as she knelt by his left side. The wide-eyed stare and open mouth he directed at the heavens terrified her. Martin looked as if the last thing he'd seen was Satan's laughing face coming toward him. Katerina did a jaw thrust to open his airway. Her right ear hovered above his lips as she peered down at his chest—hoping to feel his warm breath against her skin. As she waited to see if his life and hers had ended, Katerina prayed for a miracle.

A wisp of air like the fluttering wings of the Holy Spirit caressed her ear. She saw the blood-red shirt Martin wore rise and fall slightly with his shallow breaths. Her fingertips moved to his neck and she gasped with gratitude for the strong pulse there. Katerina reached out to gently touch his mind—

And felt nothing. She sobbed as her miracle was snatched away. Martin's body was still alive—but it was like a dried cocoon left empty by a long-departed butterfly. Katerina stroked the pale forehead of the man she loved—as if her fingers could meld into his flesh and give him the handhold he needed to pull himself up from the abyss he'd stumbled into. Her mind

delved deeper into the void within his brain—searching in the darkness for any hint of consciousness that would tell her he wasn't forever lost.

Her thoughts plunged deeper into him. *Don't leave me, Martin! Come back to me!*

Then Katerina sensed the whisper of another awareness at the boundary of her enhanced senses. *Follow me, Martin! Let me help you!*

From out of the depths his mind touched hers. Together they rose back into the light—

Martin groaned. He looked up at Katerina's tear-streaked face, touched her lips—and then bewilderment twisted his face. "What happened?"

"I don't know, Martin. It was like something grabbed and squeezed my mind so hard the pain made me black out. I just woke up a few minutes ago."

"The last thing I remember was..." Martin's gaze turned distant and vacant. As he absorbed sights and sounds on distant Earth his face contorted with horror.

He staggered to his feet. "It was like I was asleep all that time having a terrible dream. But my mind must have still been linked to everyone on Earth—and it's all real! Everything I saw in my nightmare—the nuclear war, the suicides and murders, Dr. Stone and everybody at Mission Control going crazy—it really happened!"

Katerina stood up and tried to kiss his lips. Martin ignored her, walking away and shouting, "Why did it happen? What went wrong?"

Katerina reached out to blend with his mind again. The ghastly visions she saw in it sickened her. Either Martin had gone mad—or the world had.

Then he was walking back toward her—his enraged face almost as ruddy as the soil they stood on. "What did you do, Katerina? I remember now I asked you to help me! *What did you do?*"

"I helped you, Martin. I used my own power to nullify yours."

He stopped ten meters away and stared at her. She wondered if the Savior had looked the same way at Judas in the Garden of Gethsemane.

Martin clenched his fists. "Why did you do that?"

"I couldn't let you enslave everyone on Earth—and I had to prevent them from hurting you! I didn't know there'd be some kind of mental backlash that would make us both lose consciousness when I did it!"

"No, Katerina, you must've done more than that! Just stopping what I was doing wouldn't have caused all that death and destruction! I begged you for help—and you betrayed me! Were you so jealous I was proving you wrong—that despite what you said, my power really was helping people—that you *made* me fail?"

"No, Martin! I'd never intentionally hurt you or anyone else! I don't know what caused everyone on Earth to go insane! Maybe if we work together we can stop the killing and heal those who are still alive! Look into my mind and see I'm telling the truth!"

Martin's voice held only hatred and contempt. "No, Katerina, you have the same power as I do. You can make the thoughts you *let* me hear lie to me. I need to know what you did so I can prevent you from doing it again and killing more people! And the only way I can be sure you're really telling me the truth is if I *force* it out of you!"

Martin strode toward her like an executioner. His mind whipped out and squeezed hers in a mailed fist. Katerina screamed with skull-splitting agony at his brutal psychic assault. She reflexively raised her mental barriers again—barely able to defend herself from Martin's relentless telepathic attempt to rip through her brain searching for an admission of guilt that didn't exist.

Last night she'd faced death and expired with quiet dignity, with only fleeting doubts and fears clouding final resignation to her fate. Today she saw Death walking toward her wearing the face of the man she loved—and this time she was very afraid.

* * * *

On Earth, Nature responded to the rage in Martin's mind and joined humanity in going mad.

Calm winds suddenly whipped up into hurricanes and tornadoes. In the Missouri Ozarks a three-year-old girl whimpered in her bed. In the next room her reunited parents screamed at and attacked each other—obsessed with revenge for every disagreement in their marriage.

Then a revived tornado slammed into their house and passed on, searching for more victims. In its wake the tornado left a crumpled pile of wood and metal with nothing alive inside.

In a city on the West Coast a mother and her newly healed young son vacantly hugged each other and wept over all the pain and loss they'd endured. The hospital they sat in trembled as tectonic plates kilometers away shifted. As the earthquake rocketed up the Richter scale their building and hundreds of others crumbled, leaving mangled bodies inside the wreckage.

In southern Africa the gentle raindrops nourishing accelerated crops suddenly grew and froze into deadly baseball-sized hail. Rampaging flash floods washed away plants, animals, and whole villages. Elsewhere ocean waves churned to skyscraper heights, capsizing ships and ferries. Tsunamis struck costal regions, leveling towns and cities. Lightning flashed and struck, turning acres of forests and jungles into infernos. Every minute air, water, fire, and earth slaughtered thousands more people.

* * * *

On Mars, Nature also joined Martin's side in a deadly personal battle. The peaceful garden beside its two combatants tore itself apart. Green bean bushes, cornstalks, and wheat uprooted themselves and rocketed toward Katerina's face like shrapnel. They were too light to hurt her directly—but the distraction of deflecting them with arms and mind weakened her defenses against Martin's continuous telepathic attack.

She stumbled backward—battered by mental blasts like a tornado's winds. All around her, Martian dirt swirled up and enveloped Katerina in a miniature dust storm. A barrage of pebbles stung her face like a swarm of hornets. She winced as small rocks flew up and pummeled her blue jumpsuit.

Coughing and choking from the dust infiltrating her nose and throat, with a desperate burst of telekinetic power Katerina repelled the soil and winds around her. For seconds she stood in the clear eye of a hurricane. As the frustrated Martian dirt and air raged furiously in an opaque fog a meter away from her, their attack barely held back by the force of her mind, she concentrated the remainder of her mental energy on repelling Martin's unceasing attempts to seize and viciously probe her brain.

Suddenly Katerina saw a pair of bare hairy arms reach out toward her from that dense reddish-orange cloud. She didn't notice the maniacally swirling dust nearby collapse back onto the ground as Martin grabbed hold of her shoulders. Katerina cringed at the savage face staring back at her from centimeters away. Her mind reverberated with deafening words.

"It's your fault everything went wrong, Katerina! What did you do? Confess! Tell me what you did to sabotage me!"

Katerina jerked back from Martin's brutal grip and struggled to break free. He shook her until she tripped over her feet and tumbled backward. She gasped as her back struck the hard Martian soil and Martin fell down on top of her. He pinned her arms against the dirt before she could try pushing him away. Katerina writhed helplessly beneath his heavy body as he tore away the last thin layers of fading will-power she had protecting her from his assault.

With his attack on the verge of consummation there was only one way to stop him and heal the sickness inside his mind. There wasn't enough time to convince him of her innocence or even to pray. Through the maelstrom of fury assaulting her consciousness she hoped he'd hear her last words to him and understand.

"I love you, Martin. Good-bye."

* * * *

Martin grunted triumphantly when he felt the fallen woman crushed beneath him go physically and mentally limp. All resistance to him collapsed and he began to penetrate her innermost depths—

Suddenly he stopped and raised himself to a kneeling position. His mind delved deeper into a blackening void whose final glimmer of light faded and disappeared.

Katerina lay motionless on her back with her eyes closed—as if she were sleeping. Her face was powdered with dust except for scattered lines like a spider's web on her cheeks, where tears had cleaned away the filth he'd flung at her. The blue jumpsuit she wore was ripped where he'd manhandled her, exposing the pale imprints of his fingers on her bare flesh. Her auburn hair was matted and tangled beneath her lolling neck.

"Katerina! Are you all right? I didn't mean to hurt you!"

There was no response. His heart raced as he moved rapidly to her left side and reflexively began the CPR protocol he'd used on her only yesterday. Yes, she was still breathing and the carotid pulse he checked was strong. Her body was still warm and alive.

But her mind was gone—wiped clean as her last act in life. Martin wailed in grief as his consciousness found nothing within her brain but the lowest autonomic activity. Her personality and intelligence, her ability to think and love had vanished—and not even the great power the aliens had given him could bring those things, could bring *her* back to him. She'd prevented him from becoming her murderer or worse ... by destroying herself first.

Shocked back into a semblance of sanity by her self-sacrifice, Martin bent down over the empty body of the woman he loved and kissed her forehead. His heartbroken sobs slowly subsided. He wanted to die now, he *deserved* to die—but not yet.

No, first he had to help whoever was still alive on Earth. There might be enough survivors even after this day of Armageddon to eventually rebuild

civilization.

Kneeling beside Katerina, Martin raised his lost bride-to-be's upper body enough to embrace her. Then his mind reached out toward a wounded world. He saw the raging winds and other destructive forces of Nature stirred up by his anger and calmed them. Next he directed his power to manipulate matter, energy, and gravity at the radioactive ruins and clouds of dust, soot, and smoke that covered huge swaths of post-World War III Earth. Those death-dealing isotopes and molecules were gripped and flung out into space on high-speed trajectories toward final resting places in the Sun.

Then Martin turned his attention to the physical injuries inflicted by war and smaller-scale violence. Across the world, burns, broken bones, and radiation-induced damage to vital organs were all healed.

Finally a command inspired by a favorite TV episode spanned the distance between him and every other living human being. What remained of humanity was too weak and distracted to resist his order.

Sleep.

Across Earth bodies slumped to the ground and found respite from the torment within their minds. Now there'd be time for him to heal their damaged psyches. Martin's consciousness flitted through the minds of billions of his comatose fellow beings, searching for the means to restore their mental health—

But it was too late. His thoughts touched an emptiness within the remnants of humankind only slightly less than that within Katerina. Whatever personalities they'd possessed—whatever had made them unique individuals—was gone forever. All that remained were crude neurological reflexes or the rage and remorse they'd accumulated over their lives. No hint of rationality remained behind to curb their unfettered emotions or help them become human again.

A terrible pressure grew in Martin's chest. *He* was the only sane human being left alive.

Then he laughed—realizing his mistake. There were *no* sane human beings left.

"You were right," Martin whispered to Katerina's empty body—unable to muster the faith to believe her soul was somewhere she could hear his words. He remembered a line from Byron's *Manfred* he'd read in a college English Lit class.

I loved her, and destroy'd her!

And not only her—the whole human race too. The fictional Krell destroyed themselves by unwittingly releasing their own inner monsters. His guilt was much greater. *He* had known the risk. And only *he* was responsible for using his power to strip his fellow beings of everything that made them human—leaving only their lowest animal impulses and instincts.

Martin's arms were too weary and unwilling to release Katerina to shake his fist at the heavens—and at the aliens who'd tempted him to know more than he should. His bleary eyes watched the setting Sun reach the horizon. Twilight shadows draped the barren plain and the two "gods"—one already dead, the other soon to be—alone on it. He and his lost love would share this final sunset—then they and every human being would go gently into their last good night.

His mind reached out through space one last time. With no hope for recovery, no way to relieve all that endless suffering, Martin willed the heart of every surviving person on Earth to stop. As humanity died peacefully in its sleep, it was time for Katerina and him to do the same.

The late Dr. Stone said during CPR classes that it took only about five seconds for a person to become unconscious after his heart stopped—not long enough for the last man alive to have any second thoughts. Such a simple final action for someone who'd been granted such great power over matter, energy, gravity, and...

* * * *

The noontime Sun was slowly descending from its zenith as two figures confronted each other on the ochre plain.

Martin frowned. "I'll guard myself. And I don't have to stop force with greater force. You've made me think of a better way to stop violence. Let me show you..."

His face froze. For long moments he stood petrified—as if staring at the hissing serpents writhing on Medusa's scalp.

Finally Martin snapped out of his trance and whispered, "Look into my mind, Katerina."

She did—and saw him replay a hellish nightmare. Her alien-enhanced consciousness absorbed horrifying events occurring over what seemed hours compressed into a rapid montage lasting only moments. While devils delighted at the destruction of billions, the world ended in a nuclear inferno and madness untouched by any heavenly intervention.

In that hypnotic vision of humankind's terrible last day Katerina saw herself and Martin standing here locked in a titanic struggle ending in her own self-inflicted death. As the final act of that tragedy played out, he told her what happened next.

Martin said, "Just as I was about to kill myself, I remembered what else the aliens gave us the ability to manipulate—time. I used that power to restore your health last night when you were about to die. But I wasn't sure how else I could manipulate time—or if I could use that power to save the world.

"So I experimented. I found the aliens' gift didn't let me physically travel back in time. Then I recalled a story I read in an old SF magazine. It was about a musicologist who inadvertently causes a nuclear war that destroys humanity on a parallel Earth. His 'future' self goes back in time long enough to tell the 'earlier' version of him how to avoid that disaster."

He grinned weakly. "Just a silly story by some obscure writer—but remembering it saved us and the world. I discovered the aliens *had* given me the power to send *information* into the past. So I sent my memories of

that future I created—one that *won't* happen now—back into my mind moments ago. And now I *won't* make the mistake of trying to change human nature too much or too soon!"

Katerina said, "Why didn't you send your memories farther back into the past, to before you started changing the weather or healing people?"

"I couldn't bring myself to do that. Maybe you were right about that too and something bad will eventually come out of what I did to help them. But I couldn't let those people suffer and die!"

Martin stepped closer to her. "I learned a humiliating lesson, Katerina. I was so eager to stamp out stupidity, hatred, and evil in others that I forgot they're part of me too. Before I can control others, I have to control myself first.

"I made a terrible mistake—but I've learned from it. The next time I try to improve the way people think I'll be more subtle and test it on only a few of them first—"

"*What?*"

Katerina looked furious. "I just saw how you and your good intentions exterminated the whole human race! Are you going to risk doing that again?"

"I have to do *something* to make the world better, Katerina! It's so full of greed, ignorance, and violence that it'll eventually wreck itself if I don't change things. I have a responsibility to use my powers to save the Earth!"

"And do you think that's what the aliens want you to do—or will even *let* you do? We don't know why the aliens forced their 'gift' on us, Martin. We don't know why they chose *us* to receive it.

"Maybe we're just a sick, depraved form of entertainment to them. Right now they could be waiting to see what you'll do next—hoping that foolish insignificant ant I'm talking to will think up some new way to inadvertently torment and destroy his entire anthill. And when it *does* happen again—when you've amused them once more with your antics—they'll watch you

use the power they gave you to undo all that damage for yet another fruitless try!"

Katerina sneered, "As flies to wanton boys, are we to the gods; They kill us for their sport.' But once you've annihilated and recreated humanity enough times, maybe the aliens will get bored. Perhaps, after you've left the Earth once more in flaming ruins and massacred billions, as a parting joke they'll remove your ability to make it right again.

"Imagine how they'll giggle as you realize that *this* time you've destroyed the world permanently. As the final curtain falls on the human race, maybe they'll let you hear their applause for a fine performance before they head for another inhabited planet searching for someone else as gullible as you!"

Martin shifted his feet and tried hiding the doubt bubbling up in his brain. The confident look on his face sagged. "I don't know what to do, Katerina. I want to do the right thing—but I'm not sure what the right thing is!"

"Then follow the rule Dr. Stone mentioned in one of his classes. He told us physicians always want to give their patients the best treatment—but they don't always know what the best treatment is. So they follow the precept 'First, do no harm.' If you're not sure how to use your power—and I pray you aren't—then *don't* use it.

"I don't believe you, I, or any human being is wise enough yet to know how to use this much power. If I could, I'd pluck the aliens' 'gift' out of me and fling it back at them! Better to be 'only' human and do whatever limited good we can than to be a 'god' and commit terrible sins, even with the best intentions!"

Katerina's mind touched his. "If you could, Martin, would you become human again with me?"

Martin felt his surroundings melt into a mystical vision. The beautiful woman standing nearby seemed transfigured into a heaven-sent saint glowing with otherworldly radiance, calling him to repentance. The golden cross hanging from her neck swayed like a hypnotist's watch—drawing him into a trance.

His desire to regain this celestial being's love and approval tempted him to submit to her will. The deadlocked struggle raging inside his soul tilted slightly—just long enough for him to say, "Maybe I would..."

The smile emanating from Katerina's angelic face almost convinced him he'd said the right thing. Then a sense of intense dread snapped him back to reality.

Martin's skin tingled with prickling fear. His gaze whipped around the landscape, searching for his terror's source but already knowing what it was. He felt its ponderous presence like the bottom of a giant's foot rushing down to crush him into a Martian grave.

An impossible living mass of sparkling pinpoint lights writhed and undulated several meters away. Their countless numbers scintillated in every color of the spectrum, like the manic motion of every star and galaxy in the cosmos seen by some eternal being peering in from outside the Universe itself.

Then he and Katerina waited while the aliens decided their fate.

* * * *

Sweat trickled down Martin's sides as the aliens focused their attention on him. A passionless voice rippled at him from infinity.

You wish to renounce our gift.

Martin glanced at Katerina. The sad plea in her puppy-like eyes melted whatever resistance he could mount. He whispered, "Yes."

Then it was Katerina's turn for attention.

You wish to renounce our gift.

"Yes!"

The shimmering lights expanded toward the two of them—twisting menacingly in psychedelic hues.

You both wish to renounce our gift.

Martin nodded slightly.

Katerina screamed, "YES!"

There is nothing to renounce. You never had the power you thought you had. Your ability to understand and manipulate what you call Nature is limited by your own nature.

We do not have your limitations. Each time you believed you were manipulating matter, energy, gravity, and time, we responded to your thoughts. We created and did what you wished. Everything you saw, heard, thought, and felt beyond the range of your own minds and senses you did through us.

Katerina murmured, "So you really are like Descartes' evil genie."

Martin frowned. "Who? Oh, you mean the—"

Katerina interrupted, "I think what you did was a test. You wanted to see what we would do with godlike powers. Well, we don't want them! Yes, we have great limitations—but despite those limitations we're still capable of great things.

"We don't *need* to be as powerful as you to love, to feel compassion and caring, to fill our world with happiness and joy. Even if our intelligence is nothing compared to yours, it's enough to let us marvel at Creation and use whatever science we can develop to explore its mysteries. We may never be able to travel to other planets and stars as easily as you—but when we do, we'll have earned that destiny!"

Martin began, "I'm not sure they're really interested in what you're saying —"

Katerina continued, "It's that curiosity, our need and struggle to explore, to learn all we can, that makes us what we are and gives our lives meaning! I

feel sorry for you if you already know all there is to know. What gives meaning to *your* lives?"

Martin cringed—expecting the aliens to be so annoyed after Katerina finished pontificating that they'd zap the two of them into quarks. But as the seconds passed he relaxed slightly. Maybe his overzealous fiancée had managed to beard the lion—

You are a curious species. Your “Earth” is one of many worlds we tend and nurture. When your planet was young, we made it possible for life to one day arise on it. We moved and settled it into an orbit ideal for life based on water and carbon chemistry to develop over time.

We made a body similar in size to this one collide with your world to create a moon large enough to produce higher tides, slow its rotation, and reduce its winds to accelerate the development of complex life. We adjusted your planet's axial tilt to make seasons that would moderate its temperatures and directed small bodies rich in organic chemicals to strike it.

After we prepared your world and sowed those seeds on its fertile surface, we waited to see what forms life would take. When a path proved sterile, with no hope of developing a suitable level of sentience, we altered your planet's biosphere by directing more bodies to strike its surface and by other simple methods. This let other types of life come to dominance and follow new paths.

Martin shuddered. It was one thing to read a science fiction story—quite another to be living one. If the aliens were telling the truth, those mass extinctions in Earth's past weren't random accidents—

Your species is the most promising your world has developed. We have given you every opportunity to show us you are suitable. We moved the two planets closest to yours deeper into your sun's habitable zone. We altered them to make it easier for you to travel to and live on them. Then we waited to see if you would send the best your species has to offer to discover why we did it.

Martin suppressed his chuckle at being described as “humanity's best.” The aliens could read his thoughts—and they might not value humility or self-deprecation.

As you approached this planet we created an artifact to evaluate your curiosity and encourage you to stay here. We made a second artifact to motivate you as strongly as possible to accept our gift. We have watched how you used that gift.

All this has been done so you could show us what you are. You have been tested to see if you are suitable.

Katerina said, “We've shown you our best and our worst—our weaknesses and our strengths. We make mistakes—but we *learn* from them. We can be foolish—but we're also wise enough to realize that we shouldn't keep your gift. With all our faults, we can still feel love and compassion great enough to even give up our lives to save others. Based on *everything* you've seen, I hope you do find us ‘suitable.’”

You have indeed shown us what you are.

Martin glanced at Katerina. The serene expression on her face was the same an ancient Roman martyr displayed before a mighty emperor—confident he could only break her body and never shake her faith.

The aliens spoke again. *You have failed our test. You are like the animals you call cattle and sheep. Your kind has no future.*

We grant you enough time to prepare for your end.

The shimmering lights lingered for a moment before disappearing. A cold breeze ruffled the clothes of the two human beings standing alone on the silent plain. Each of them pondered the parting words of the vanished aliens.

Both of them were afraid—and one of them seethed with a growing anger.

* * * *

Stone's attention seesawed between the TV monitor showing reports of medical and meteorological miracles, and the mammoth screens in the front of the room. He kept hoping for another transmission from Mars to explain why so many inexplicable good things were happening and to ease his fears that they were the prelude to some catastrophe.

Then he noticed Nancy Kelley, newly returned from her press conference, huddling at the other side of the room with several of the project's other senior people. The worried expressions they shared indicated that whatever they were discussing wasn't good.

Kelley separated herself from the group and walked toward Stone. He met her halfway and said, "What's going on?"

The flight director murmured, "I'm not sure—but if the aliens really have turned hostile, it may mean the end of the world!"

* * * *

Martin was the first to move after the aliens left. He ignored Katerina and trudged past her, heading back toward the habitation module.

She caught up with him. "What do you think they meant, Martin?"

He scowled wordlessly at her and kept walking.

After Martin mutely rebuffed that same question again, Katerina resigned herself to patiently accompanying him back home. The tension between them was so strong and distracting she nearly slipped several times—as if the ground were shifting beneath her feet.

When they reached the module she followed Martin into its communications center. Still waiting for him to speak, she watched him sit down and activate their primary transceiver.

"Mission Control, this is Slayton speaking, audio only. I'll send a detailed description of the situation here after you acknowledge reception. Over."

As they waited the several minutes it would take that message to reach Houston and receive a reply, Martin acted as if he didn't see his fiancée sitting beside him. Katerina tried reassuring herself that he couldn't stay angry forever.

Then he looked at her and hissed, "Is there anything you want to tell me, Katerina?"

"I don't know what you're talking about, Martin!"

"No? Just before they disappeared, the aliens gave me a private telepathic message. They informed me you really *did* sabotage my effort to save humanity! You used your 'power' to pull a stunt on me from one of those grade-Z 1950s science fiction movies I showed you during our flight here, *Invasion U.S.A.*

"I let you have free access to my mind to show you I had nothing to hide—and you took advantage of my trust! You used your power to put those ideas in my head about how to change human nature—and then you hypnotized me! And while I was in that trance you told me what the aliens said you called a 'noble lie.' All those terrible things I thought I did—everything that seemed to happen to you, me, the people at Mission Control and throughout the world—*none of it really happened!* I thought I'd saved the world by using one bad SF cliché. Instead you made me fall for the biggest cliché of all—'It was all a dream!'"

Martin shouted, "I only *thought* I tried to change human nature! I only *imagined* I destroyed you and the whole human race! Those 'memories' I seemed to oh-so-cleverly send back through time were just a noontime nightmare *you* created inside my mind using my own thoughts, doubts, and fears—a nightmare that seemed to go on for hours but really lasted only moments! It was all just a mental melodrama you deliberately directed—even acting out the role of my 'innocent' victim—to convince me I was wrong about how we could help humanity!"

"*That's* why we failed the aliens' test to see if we could improve human nature—*because you never let me try!*"

A voice at Mission Control crackled from the transceiver's speaker. "Stone here. Please describe your current medical condition and Savitskaya's. Let us know if either of you is in any immediate danger."

Unintelligible voices murmured excitedly in the background before Stone continued, "I've been asked to tell you that the orbiters at your location and ground-based observations indicate Mars is experiencing a significant new decay in its orbit. The planet's rate of movement toward the Sun is more rapid than when the aliens moved it previously."

"There's insufficient data yet to determine where or if Mars will resume a stable orbit. If you have any information about this new anomaly, please send it immediately!"

Martin looked at Katerina contemptuously. "Well? Should I tell them what happened? You were afraid I might accidentally destroy the human race if I tried to help it. Now, because of *you*, it will be destroyed!"

"What do you mean, Martin?"

"You were so sure the aliens were surrogates of Satan, tempting us to accept and use power we shouldn't have, that you didn't think how things might look from *their* point of view. Instead of improving humanity like they wanted us to do, you tricked and pressured me into joining you in throwing their gift back in their faces. No wonder they decided we were a couple of cowardly obnoxious ingrates and that our entire species wasn't 'suitable' for their help!"

Martin sneered. "Don't look at me like you don't know what happens next. You heard what Stone said about Mars moving toward the Sun again. The aliens practically confessed to redirecting an asteroid to wipe out the dinosaurs and causing other mass extinctions. They also claimed to have created the Moon by slamming a Mars-sized planet into Earth billions of years ago.

"I think they're planning to do it again with the *real* Mars—and when those two worlds collide it'll be the last thing the whole human race ever sees!"

Katerina stammered, “I can't believe—” But the heavy hands that this time grabbed and shook her shoulders for real cut her off.

Martin glared at the deceitful woman he'd loved and screamed, “*What have you done?*”

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* * * *

(*EDITOR'S NOTE: Martin and Katerina appeared earlier in “The Last Temptation of Katerina Savitskaya” [September 2008].*)

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Reader's Department: **IN TIMES TO COME**

Our January/February 2010 “double” issue marks the 80th anniversary of this magazine, the oldest of its kind and still a leader in its field. We mark the occasion with a special essay by Ben Bova, the only being in the Universe (literally!) who progressed from being a regular reader of *Astounding* (as it was known for its first 30 years), to writing for it, then editing it (to wide acclaim), and then returned to being a writer and reader—so he has a genuinely unique perspective. And, of course, we celebrate with an extra-generous dose and wide variety of fiction, including three of the big pieces that are hard to fit in a regular issue. All of those are new entries in popular series—Richard A. Lovett's “Floyd and Brittney,” H. G. Stratmann's “Paradise Project” on Mars, and Kristine Kathryn Rusch's “Retrieval Artist”—but all also break substantial and thought-provoking new ground. We'll also have stories by other authors both new and familiar, including Maya Kaathryn Bohnhoff, Michael F. Flynn, Mike Resnick (with collaborator Lezli Robyn), and Eric James Stone.

The extra room in the double issue also lets us do extra things in the nonfiction area: two fact articles (on the nature of culture and the non-identical nature of twins), and two special features (Ben Bova's aforementioned memoir, and another of Richard A. Lovett's helpful bits of advice on the art of storytelling). All of which makes a package with plenty for everybody.

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Serial: **TO CLIMB A FLAT MOUTAIN: CONCLUSION** by G. David
Nordley

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Illustration by Vincent Di Fate

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Even in a place as bizarre as Cube World, the worst problems humans face are likely to come from other humans.

* * * *

Part I synopsis

Jacques Song wakes up from cold sleep to find himself underwater looking up through the transparent cover of his cold sleep unit (CSU) at a large predatory fish with a huge parrotlike beak. He went to sleep in a hotel room expecting to wake up at a base in the Kuiper Belt of the 36 Ophiuchi system. There he was to take part in a huge expedition to liberate a colony taken over by a cult nasty enough to justify an attempt at interstellar warfare. Something had gone very wrong.

The CSU's computer has only limited knowledge of what has happened and no knowledge of why. Jacques' starship, the Resolution, failed to engage its deceleration pellet stream at 36 Ophiuchi and had spent the last thousand years decelerating by other means, losing the last of its velocity by crashing into the atmosphere of the only habitable planet it could reach and dumping its cargo of CSU stored passengers into and around a volcanic crater lake. Running out of power, the CSU has revived Jacques to fend for himself.

With an emergency kit nobody thought would ever have to be used and no source of power, Jacques must escape the lake floor, evade the predatory fish, and reach shore. All the electronics in the emergency kit are dead. Fortunately, the skin-tight all-purpose survival suit is powered by his body heat and motion and works perfectly. Enclosed in his suit, Jacques is able to flood the CSU, pop the lid, evade the fish, reach the surface, and navigate through huge but gentle waves to a black sand beach. In this effort, he finds himself feeling exceptionally strong and vigorous.

The world's gravity, it turns out, is about equal to that of the Moon. Still, the feeble stellar wind from its old red dwarf star has apparently been insufficient to blow the atmosphere away. Indeed, where Jacques has landed, the pressure appears to be several times that of Earth's atmosphere. The partial pressure of oxygen also seems greater, accounting for some of his endurance and strength.

Jacques will attempt to rescue other survivors, but first he has to assure his own survival. The vegetation inside the caldera is sparse, so he sets out over the crater rim to find what he can on the exterior slopes. At the rim of the crater-lake caldera, Jacques discovers three impossibly huge distant mountains right, left, and in front of him whose perfect triangular peaks and connecting ridges seem to rise above the atmosphere.

Descending into the forest below the ridge, Jacques manages to find sustenance among the native life, though he comes close to the end of his emergency rations. He has close calls with huge creatures that resemble a cross between a kangaroo and a dinosaur and with batlike scavengers the size of a small airliner. With no recorder or even paper and pencil, Jacques is reduced to scratching short notes in stone to record his progress. He leaves these on cairns that he builds at his various campsites.

*On his way back to the crater-lake, he discovers a windblown page from the diary of a woman he knew briefly in training—**Ascendant Chryse**. Arriving at the rim in evening, Jacques finds a lava tube for shelter. Rising before sunrise, he spots the shrunken, distorted constellation of Orion. It is still recognizable because the Resolution had come from that direction. But just off to the side is an intensely bright red star. It can only be Antares—which means the Resolution had bypassed the supergiant star and they were now*

farther from Earth than it was. Jacques' stargazing is then interrupted by a hungry megabat and he must hide deep in his cave.

After sunrise, Jacques decides to build a raft for the rescue effort. He goes back into the forest to get logs and twine. There he establishes "Forest Camp" and commutes back and forth to Second Landing beach carrying one log at a time. On his last logging trip, he stumbles on Ascendant Chryse's CSU just in time to watch a "megabat" break into her CSU and carry away her body. On reaching the CSU and her camp, he finds that she had been murdered when someone, or something, turned off the power to her CSU while she slept, trapping and suffocating her. He finds her diary and on its last pages reads that someone on the ship had sabotaged its deceleration mechanism. He takes her diary and the memory module from the CSU and holds a brief ceremony for her that night in his shelter.

*Back at his crater-lake shore camp, "Second Landing," Jacques builds a raft, the Resolution II, and is able to find and rescue three people: **Submahn "Soob" Roy**, a former park ranger and logistics expert; **Collette Obota**, an expedition policewoman; and **Dr. Yu Song-II**, a psychiatrist they call "Doc." The raft almost falls apart during the trip and they barely reach shore alive.*

Needing more food and a bigger raft, the group of four set out for the other side of the Caldera Rim. While Soob and Doc are bringing back the hollow logs packed with food, Jacques and Collette stop by the Ascendant Chryse site to salvage more electronics. On the way back to the rim they are hailed by a large man draped, Robinson Crusoe-like, in a kangasaur skin tunic.

*His name is **Gabe Eddie**, a psycho-warfare expert from a Baptist space colony, New Jerusalem, in the Solar System. He tells them his CSU landed in the forest and he found them by following Jacques' cairns. To save their survival suits and keep comfortable in the hot, high-pressure climate, Jacques and the others have gone naked. This bothers Eddie, as do Collette Obata's assertiveness and questions. In turn, she and Jacques find Gabe's answers and manner a little hard to believe.*

*Once back at Second Landing, they rebuild the raft and rescue **Edith Lu** and **Maria Lopes** from CSUs. When they get back to camp they find that*

Leo Suretta, Evgenie Malenkov, and Arroya Montez have joined the group, apparently walking in from the forest. These tend to side with Gabe on several issues.

One more rescue voyage is attempted, which finds physicist **Helen Gorgos** and **Dominic Oporto**. The small community now sends out foraging expeditions. Jacques and Collette go on one and in addition to supplies, salvage more of Ascendant's CSU. Jacques is able to get some of the equipment working and discovers that a shuttle from the Resolution apparently survived reentry and is somewhere west of them. They suspect Gabe and Leo, at least, have not been fully honest.

They also have a close encounter with another megabat and by necessity discover that they can jump on the creatures, ride them, and even steer them somewhat by pulling on their ears. They get a great view of the geography of their planet and decide that what they can see is a square, and suspect the entire world may be cube shaped.

When they return, they find things have been heating up, physically and politically. Gabe and Leo have staged a sort of coup. Forest fires have broken out, and Gabe decides the group should remain at the lake, while Jacques and others think they would starve there and opt for escaping to the sea surrounding the volcanic island, as most other large animals seem to have done. No agreement can be reached and the community splits acrimoniously, with Jacques, Collette, Soob, Doc, and Helen striking out for the coast.

The small breakaway group crosses the rim and heads toward the coast as fast as they can. They barely survive the fire sweeping the island by staying close to Deliverance Creek. Exhausted and hungry, they manage to jump on a megabat feeding on a kangasaur carcass. It doesn't stop at the coast; it carries them west toward the unknown slopes of the great flat mountain on the other side of the sea.

* * * *

Chapter 12

At the Edge of Forever

Hours passed and the western shore came into view, then passed beneath them. The land, so flat from a distance, was anything but as they neared it—filled with terraces, gulches, waterfalls, and ridges. Their approach was disorienting. Their eyes told them the megabat was diving down into a roughly flat landscape, while all their other senses told them it was flying level.

"Keep thinking 'mountainside,'" Doc said. "Or you could get sick. Look at the angle the trees make with the land."

That helped quiet Jacques' stomach, at least. But the fact that they could see individual trees also rang an alarm bell. Whether descending or flying into a mountainside, they were rapidly approaching the end of their flight.

"We need to get ready to get off!" he shouted. "We'll need to run for the trees, or someone will be its next snack."

Though famished, everyone was well rested. They quickly untied the lines, stowed them, and helped each other strap on their kits. The megabat settled down in the tree-crowned top of a huge pillar that had become slightly detached from a terrace cliff. As it settled down in a clearing, a number of much smaller versions of itself—each still twice as large as a person—came hopping out of the surrounding wood to greet it. That proved more than enough distraction for the humans to jump off and run for shelter.

"Okay, gang," Collette said, on catching her breath. "We've eaten one tiny meal in two days and we're trapped on a sky island plateau filled with huge predators. Why do I feel like I just got out of school?"

"Stress relief," Doc said. "We still have big problems, but they aren't immediate problems."

Everyone laughed. Something scurried away—a hirachnoid.

"Dinner, anyone?" Soob asked.

"We need a place to sleep and I don't see anything resembling a cave," Collette observed.

"The trees are different here," Jacques noted, thinking aloud. "They have more branches and a wider crown. There might be a place to build a platform. Over there." He pointed to a tree with wrinkled gray bark and two lower branches that came out at almost the same level, about three meters up. "Okay. Soob, Collette, and Doc, why don't you forage. Helen and I will try to make a platform for us."

As the hunter-gatherers left on their mission, Jacques and Helen constructed the nest, using the nearly indestructible line from Helen's emergency kit to make a web between the branches. They filled that web with whatever branches they could find lying around and secured those with a local vine that, while not green twine, served almost as well. Helen called it pseudotwine. Jacques left the construction to Helen while he gathered material.

"Come on up," Helen said, throwing down a psuedotwine vine tied to an overhead branch. He pulled himself up easily hand over hand in the low gravity and lowered himself onto the platform; it was springy, but didn't feel like it was going anywhere.

Still, he felt better sitting down. Helen had resumed her customary state and stowed her shipsuit in her kit, which was hanging from an overhead branch. She waved at it, saying, "Save the suits for when we need them."

Despite having gone unclothed, or nearly so, in for over a month, having been clothed for a few hours had put Jacques back into another cultural mode, and he hesitated. With a sly smile, Helen reached over and, starting at his collar, began to peel his suit off like a banana skin.

When she got it off him, she began to cuddle. "Time for dessert," she said.

He laughed and gently pushed her away. "Too tired, Helen. I'm just too worn out."

They spent the next few days resting, hiding from megabats, and foraging. The clear day of their arrival proved a fortunate rarity; more typical were misty mornings and gentle midday showers. It was more temperate here, with daytime temperatures in the high 20s; air pressure was down to around 3,000 millibars and more variable than at New Landing. The view from the tree was spectacular, but a week after their arrival, they were rested and provisioned; it was time to move on.

They packed up camp at noon the next day, with the megabats safely in their daily slumber, and explored the western edge of their sky island, looking for a way across the gap.

"It's like Meteora, in Greece," Helen said. "Except ten times bigger. People built monasteries on top of natural pillars like this; they looked impossible to get to. The megabats keep their chicks here for the same reason, I think. But there is usually a back way, a thin bridge or connection with the rest of the plateau; not an easy way, but much more negotiable than the sheer fronts and sides. We just have to find it."

Jacques spotted it on the second day of looking, toward the south side of the pillar. About three hundred meters below the plateau, flutes from the pillar and plateau extended to meet each other. Almost. There was a gap of perhaps ten meters, with a treacherous narrow ridge leading to it on either side.

"Everyone. Over here," he called.

"An easy jump in this gravity," Soob said as he arrived, surveying the gap. "But staying where you land, maybe not so easy."

"There's a tree about four meters up," Colette said. "I was a long jumper in college. I think I can make it with a rope around my waist."

"Remember the air is three times thicker here," Doc said. "You'll lose speed quickly."

"What about a bridge?" Helen asked. "There are logs long enough, and we have line."

"Hmmm," Jacques said.

It was, possibly, the first suspension bridge on the planet; certainly the first human-built one. They used two twelve-meter logs; the first was erected vertically on the sky island side, set in a hole and held in place by rocks piled around it. A line, anchored to a tree, went over its top and was tied to the far end of the other log. This they pushed out over the gap, playing the line out as it went until it hung swaying over the far end. They anchored the near end with a pile of rocks, then raised and lowered the far end onto the far side of the chasm until it had pounded a secure groove for itself in the loose soil there. The party crossed one at a time, with lines around their waists in case they slipped.

To get up the gravel on the other side, they made a human road to the nearest tree. Doc lay down on the slope with his feet securely on the log. Jacques crawled up over him and, with Doc's help, placed his feet on Doc's shoulders and lay down, extending the human road another meter and a half. Helen followed, then Collette with a line that she tied to the tree toehold on the plateau. Using the bridge and ropes, they got their gear across the gap and up to the level part of the plateau. It took them most of the day. They made camp on a secure flat near the edge of the cliff. It was somewhat risky, but they were beyond tired and the view of sea cliffs below, the sea, and the top of the mist-shrouded island they'd fled was to die for.

"It's like we're on the edge of forever," Doc said.

The next morning, Jacques put up a cairn and on the more or less flat face of a rock, scratched their names and:

Day 54. Camp Edge of Forever.

* * * *

The plateau proved to be one of the terraces Jacques had seen from the far shore; three kilometers in, they were faced with a kilometer-tall rock face.

"In this gravity, a piece of cake," Collette said, looking at the rough, crevice-filled rock face. She showed them how to jam flute plant stems in cracks as big, ersatz pitons and they scaled the thing in a couple of hours.

They had enough provisions for three days' climb, which took them up over a half dozen "terraces." Jacques welcomed the break from breaking trail through the forest and the view at the top of each cliff. If they found an exceptionally tall tree at the top of a cliff, they would climb it and look back. The ocean would cover the eastern horizon, perhaps slightly bowed upward as it conformed to gravity and not the flat topography. In the far east, they could see a dark smudge, so small now that they could cover it with a hand. Smoke still rose from it like a strange plant with wispy gray leaves reaching impossibly high into the sky.

Jacques assembled his electronic gear and waited for the sun to peek through the clouds and provide the power he needed. When they got another bearing to the shuttle, it was west and south of where they were. The signal had increased in strength, but not as much as he would have expected from the ocean crossing.

Each day Jacques took readings; a hundred meters left, a hundred right. They were headed toward the shuttle, but the signal was not getting much stronger.

Meanwhile, the flora and fauna changed. The broad fleshy-leaved bitterwood tree was giving way to a very tall tree with a rough yellowish bark that covered its trunk and limbs like scales. Its foliage seemed to come from a simple modification of the bark; the scales appeared to curl into finger-sized hollow tubes.

Helen picked a leaf up from the forest floor. "The underside's translucent," she noted. "I'll bet it's a good insulator."

"Winter adaptation?" Soob asked.

Jacques nodded and stretched his hand out and covered their sun with his thumb. In the week since arriving at Camp Edge of Forever, the star had gotten noticeably smaller. "Our sun is shrinking."

"Apastron?" Collette asked.

Jacques frowned. He didn't think they'd reached the farthest point of their planet's orbit yet, but it was hard to tell how long it would be. "Not yet, but we're well past periastron now. It's not just the gain in altitude that's making us chilly."

Soob nodded. "We'll need to find a good campsite, one where we can settle long enough to make some winter clothes."

Helen laughed, then looked very thoughtful. At length she said, "We all still hope to find the shuttle, recover all our technology, and continue our mission. But it might not work out that way."

"You're suggesting we locate a permanent settlement here?" Doc asked.

Helen nodded. "At least a base camp. We'll need to stop at a place that's survivable with what we have."

"We still have a mission," Colette said.

The quiet that ensued spoke of the elephant in the room. The urgency of the quest to find the shuttle had, necessarily, abated and he imagined that everyone was thinking like he was, though not saying it. Those that had stayed behind had either survived or not—either way, they would hardly need rescuing now. Building a new starship was a very long-term project—and they had been striving for all they were worth for almost a month now. It was time to scale back to a sustainable pace.

"Maybe the next likely place after a week's climb?" he said. "That will give us a week to get ready for apastron, and the season will likely lag."

There were assents all the way around.

* * * *

Chapter 13

Eagle's Nest

They had settled into a routine, gaining about twelve kilometers a day horizontally and four vertically. At first light they were up, ate a hearty breakfast, and packed away the remaining food. Then they did four terraces, with a water break after scaling the second cliff of the day. During the break, they would recharge their electronics. The hard part of the day was the next two traverses and climbs. They would take a long rest after the fourth climb, then build camp and forage. After the sun went down, they'd have a light dinner by the fire and go to sleep, taking watch shifts.

Jacques had just gone over the top of the fourth terrace on the day's climb. The trees he saw seemed larger and farther apart than below; the effect was almost parklike. He gazed up at one giant that came up from near the terrace edge; it seemed almost twenty meters across and actually vanished into a wisp of cloud above him.

Trying to find its top, he wasn't looking where he was going and about thirty meters in from the terrace edge, he saw a small pit too late and felt the sandy ground give way under him. He tried to scramble back, but the ground gave way faster. "Falling! Belay!" he yelled as he slipped beneath the surface. His belay line pulled taut, and he soon found himself dangling about five meters below the surface in a huge cave. Below him was a pile of sharp rocks, many as big as small houses. Lava tube, he thought, when he stopped shuddering. The ceiling must have caved in here a long time ago—forest debris had almost filled in the hole. As his eyes adapted to the light, he could see that the volume around him was immense; the cave must have been a hundred meters across in places. He could hear a small stream running through it.

Water supply, drainage, shelter, defendable ... he ticked through various pluses. "Soob," he yelled. "Soob. I think I've found it!"

When the group all reached the hole, they descended on ropes and explored the cave. It led toward the face of the terrace, and as it did, the floor became smoother, like the dried bottom of a creek. The creek itself ended in a pool.

Helen shook her head. "I can feel wind. The terrace face must be within a few meters of us."

Colette nodded. "The pile of dirt across the pool—it's not lava. It looks like it came this way, inward from the face, not down the tube." She waded through the pool and climbed up it, toward the cave roof. Suddenly she thrust her arm into the wall and brought it back holding a large white flower. "We have a window!"

They built "Eagle's Nest" over the next week, enlarging the silted-up window and leveling the floor behind it until they had an opening ten meters long and a meter high toward the east. For in the morning, the rising sun, if visible, would fill the cave with light back to the skylight fall. They built a rough stone wall at the edge of that, for defense and to keep from falling off; the terrace edge was slightly undercut, and the drop to the next level must have been a kilometer.

On the second day, Soob and Jacques were hunting. The hirachnoids were larger at this altitude, with thicker legs, though Helen thought they weren't as sweet as on the island. Jacques had a couple of sets of legs in his bag when he noticed the smell.

"Jacques, something's dead," Soob said.

"I'd say so."

"Hirachnoids are scavengers," Soob added.

"I was afraid you would mention that."

Following their noses, they found a megabat carcass, maybe three days old. Hirachnoids were going in and out of its cloacal opening, now somewhat enlarged, covered with little bits of what had been inside.

"I'm going to be sick," Jacques said, and turned to retch. When he was over it, he turned back to see Soob busy slicing away the webbing of the carcass's right wing.

"Fur coats," Soob said. "I don't think it's been above ten Celsius since we got here."

Disgust aside, Jacques realized that fate had handed them a treasure trove. He quickly went to help. Soon, they had all the wing web pelt they could carry. Just as well, he thought, with a glance at one of the large, glistening hirachnoids.

They dug an outlet for the pond and rigged a floodgate for it. All that nice, smooth silt had come from somewhere, and they didn't want to be washed away by the next rainy season. They found a "bottomless" crack near the cave mouth across the pond from their camp. With a short stone wall for privacy, it would now have its share of bottoms.

It snowed on the morning of the third day, in huge flakes as big as their hands. Almost ten centimeters of soft white snow built up in about no time, but it quickly melted. The storm did show them that the cave was too drafty, so they wove a barrier out of yellowbark branches that they could use to cover the entrance at night.

The long days were full of unending labor; every fallen log from several kilometers around found its way down the skylight. Everything edible they could find went into the hole, too. Jacques figured they had about fifteen days of supplies when winter hit in earnest.

It snowed heavily on the fourth day of occupying Eagle's Nest, gusts of wind bringing flakes through the cave. Despite their barrier, the freezing wind found its way to them and they huddled close in their blankets. They fed the fire frugally and waited, then finally arranged a fire watch, using a crude water clock as a timer—it let a stone fall when the cup became too light—and slept.

Jacques had the first shift and spent much of it in wonder at how he'd gone from a reasonably prosperous childhood on Cislunar L5 Grissom to his present circumstances. He wondered about his mother and father: Where were they now? They'd certainly have given him up for dead and had likely passed on one way or another themselves.

Did they keep their religion to the end, he wondered. Did they ever regret the beatings? How could one profess love one minute, then scream and hit the next? He had never married; what happened to him ran in families and

he had vowed it would end with him. He was going to have to have an honest talk with Collette.

The rock dropped, surprising him. He put another piece of wood on the fire and blew the embers until it caught, then went to wake Soob for the next shift. He snuggled under his blankets and thought about humankind expanding through the galaxy, wondering how long it would take for them to get this far.

Jacques felt a gentle shaking, opened his eyes, and saw Collette, who planted a quick kiss on his cheek.

"It's morning," she said, nodding to the pale light from the cliff face window. "The wind's stopped."

Jacques yawned and pushed himself up. She reached for his hand and he found himself in her arms, naturally, unbidden. Their embrace lasted as long as it needed to—no urgency to it, but a bond renewed. They had become special to each other. Not intentionally, but it had happened. He felt comfortable, warm, and at peace in her arms. The conversation could wait, he thought.

"Let's check the entrance," she said.

Jacques smiled, wondering if it was an excuse to get away from the others.

"There's hardly a breeze," she said. "It might be blocked."

Situation awareness, Jacques thought, getting his head back to reality. They were in a survival situation on an alien world. He nodded. "Yeah. We should check."

The vertical entrance was, indeed, completely blocked, a pillar of compressed snow like a white trumpet, bell down, rising from the gnarly cave floor to its ceiling. Only the cliff-face window remained open. They were in for the season, it seemed.

* * * *

They settled into a routine of sleeping by the fire, eating, and working on small projects. They found a large piece of obsidian, with an edge of about ten centimeters width, that they could use to shave bitterwood logs. They could write on the shavings with wet charcoal, not very finely, but good enough for some haiku and other short poems.

They peeled apart the megabat web skin pelts, scraped away the small amount of flesh between the skin layers, soaked them in water and ash, rinsed them in the pool, then suspended them over the fire until they steamed, hopefully killing any decay-causing bacteria and preserving them for use. They smelled better, anyway.

Cut and folded, with a hole in the center for someone's head and a strip of skin for a belt, the megabat skins made passable ponchos. They were almost impermeable, and the short fur, turned inside, made them comfortable to wear.

They made plans for the next summer's exploration, learned each other's personal histories, and spun many untestable, unobservable theories about Cube World's origins. Doc carved a passable model of the world, complete with the slight bulges for oceans on each face.

Soob made a chess set and became their local grand master, though Jacques wondered if he would have succeeded so well if Helen had participated in his tournaments. She claimed to not know how to play, but Jacques thought she watched the board with more than casual interest.

Helen spent her time making a wooden necklace of interlaced rings, carved from a single piece of bitterwood branch. It was a topological marvel they all admired.

Many years ago, Jacques had taught himself how to play a Peruvian flute: a simple tube with a slanted notch and holes for an octave's worth of notes. He'd had that in the back of his mind when he named the "flute plant." It was a project, with some cut-and-try to get the intervals right, but finally they had four passable flutes, two bass and two tenor. Helen, Soob, and Collette learned to play, and they eventually managed a truncated, ersatz

performance of the New World Symphony, with Doc playing a batskin drum and singing "going home."

They gossiped about their days in training and various couplings imagined and real.

"Evgenie told me he had a hard time making up his mind about Ascendant," Helen said.

"I thought he was soft on Arroya," Doc said. "And he was dating you too?"

Helen laughed. "I was his safety valve! I'm a good listener and was obviously not looking for an exclusive relationship."

"When we split," Jacques said, "she was looking at you—almost fearfully, I thought. Any history there?"

Collette shook her head. "Maybe she doesn't like cops. What about Leo?" she asked. "Was he involved with anyone?"

Helen shrugged. "He didn't seem interested in anyone, that I could see."

"Not even you?" Collette smiled when she said that.

Helen laughed. "The lack of interest was mutual. There's something about him ... maybe it's stature compensation."

"A Napoleon complex?" Doc offered. "He seems content to let Eddie take the lead. Anyway, I saw him on a Chesapeake Bay cruise with Maria Lopes. She touched him in a pretty friendly fashion. Eddie was there, too, if I recall."

Jacques looked over at Collette, who looked back and frowned. They'd been thinking in terms of one saboteur and murderer; they hadn't considered more than one.

* * * *

Ten days from becoming snowbound, Jacques, trailing a tether, squeezed through the narrow horizontal crack of the window, stuck his head out into a freezing wind and looked up fifty meters at an overhang of ice-covered rock, and down to the snow-covered terrace, a kilometer below. To his right there was the bare hint of a ledge, covered with snow—which probably covered ice—that slanted down and then up in the distance toward a notch in the ledge.

It was, he realized, less dangerous than his Earth-gravity-trained intuition told him. But without an ax, crampons or pitons, it was still a suicidal traverse. He wiggled himself back in, and for a moment, the erstwhile cold damp air of the cave felt warm and inviting.

"I think," he told the assembled group, "we're better off attacking the snow pillar."

Three hours later, using the light of improvised torches, they stared up at the barely visible mountain of snow that had drifted down into, and eventually sealed off, the "skylight" entrance to Eagle's Nest. Somewhere in there was the rope they had used to come in and out.

Soob attempted climbing up the snow hill and sank up to his crotch. As he attempted to extricate himself, he triggered a small avalanche that picked him up and flung him against a rock headfirst. Helen tried to move to him and was overwhelmed herself and buried.

"Hang on," Jacques yelled to everyone left. "Let it play out!"

When the snow stopped sliding down, he began moving toward Helen, half wading, half swimming through the snow. The footing was treacherous—he found he made the best progress by lying down on the snow and pushing against the rocks with his feet while doing something like a butterfly stroke with his hands until he got to where he thought Helen lay.

Meanwhile, Collette mimicked him in an effort to reach Soob from the other side of the avalanche.

Helen was nowhere to be seen, so Jacques felt around with his feet.

Something or someone grabbed his leg and started climbing up him. Jacques cried out in startlement before he realized it had to be Helen. He reached down into the snow, found a hand, and pulled her up. Her face was ashen white, and she coughed in great hacking spasms that gradually decreased in frequency and harshness.

"Don't try breathing snow," she choked out as the coughs subsided.

"Can you make it out?" Jacques asked.

"What about Soob?" Helen asked, followed by another fit of coughing.

"We're looking. I'm not sure when this will let go again." Jacques tossed his head in the direction of the snow pile. "I don't want to lose all of us."

"Yeah. Okay."

"Watch your step."

She nodded and began to pick her way out of the avalanche area.

Jacques resumed "swimming" toward where he thought Soob's last position was. Despite the cold of the snow, he was sweating with effort. Soon, he and Collette met in the middle without having found Soob.

"It may have carried him downhill a ways," Collette said. "Let's stay in contact so we don't miss anything."

They did, slowly feeling their way through the snow shoulder-to-shoulder, foothold by foothold, steadyng each other when the other slipped.

"Jacques!" Collette said at last. "I don't think this is a rock."

Quickly, they dug down with their hands and found the still form of their comrade. They brushed the snow away from his head with their bare hands. He had bled from a scalp wound, but not, it seemed, profusely. Collette tried to take his pulse and shook her head.

"Get him free first," Doc called. "The cold may reduce his life signs. We're trying to make a smooth area for him to lie down, clear of the avalanche danger."

"Yes," Jacques said, and bent to the task of extricating Soob's limp, motionless body.

In one gravity, it would have been impossible, but the gentle pull of Cube World made them supermen and superwomen. Jacques and Collette finally freed him and built a ramp of compressed snow to pull him up to the surface. There, they dragged him as if he were a toboggan toward the edge of the avalanche. Doc and an apparently recovered Helen took over then as Jacques and Collette collapsed in the snow in exhaustion.

"The good news," Doc proclaimed at length, "is that he isn't dead. Unfortunately, that may be the bad news as well. I wish I had the resources of a hospital..."

* * * *

Two days later, they were near the end of their food. Soob was still unconscious, and though they'd managed to get some water into him, they had no IV or liquid nourishment. He could, Jacques realized, be the first to starve to death.

"It's got to be apastron," Helen said. "The weather should start to moderate. Half rations may give us four days. We could just go hungry for another five or six. Spring should come quickly."

"Not quickly enough for Soob, I fear," Doc replied.

"I think we need to try again," Collette said. "Try smarter."

Jacques reviewed events in his mind. "I could try to trigger another avalanche."

"Risky." Doc said.

"Yeah. I'll need some kind of headgear and a long tether. If I get buried, pull me out."

That was greeted with silence. Everyone realized the risk involved. But they were not going to sacrifice one of their own. One for all, all for one, Jacques thought. The beau geste. The stuff of legends. He looked around and everyone nodded.

They had one log left—in a small blessing, they'd needed less fire to keep warm than initially anticipated. Jacques planned to use it to put some distance between himself and what he thought would be the most unstable snow.

They planned it like a military campaign, beating a packed snow path between rocks to the target area. With a rope around his waist, Jacques advanced. As he approached the center, however, the path gave way, and he found his boot in water. Apparently, a melt creek was forming beneath the snow.

He extricated himself, made a "dry" snow path around the hole, and trudged on.

Then he was there. He made his way up the snow as high as he could, then used the log to bludgeon the snow above him. Nothing. He whacked it again with similar results, then he pushed the log into the snow and tried to lever some out of the pile. He was doing this again when Colette shouted.

"Jacques, above you! Look out!"

He glanced up the snow hill and saw the avalanche coming. He backed off as quickly as he could without abandoning the log—they would need it for fuel—and avoided the worst of the oncoming snow. The tether, pulled by all his companions, moved him out of the deluge.

When things settled down, there was a gap above the snow hill and the skylight, filled only by the rope they had left a couple of weeks earlier. And above that was daylight.

They tested the rope with their total weight and found it had not gone rotten. Climbing it in the low local gravity was no problem and soon Jacques and Doc reached the snowy surface. Doc, whose voice carried farther, yelled down the hole to let them know they were out. Then they put on improvised snowshoes and headed for the forest.

The landscape had been transformed; snow weighed much less here than on an Earth-gravity world and compressed much less under its own weight. Drifts towered around them, and the lava tube had been a ridge to start with.

As they neared the forest, they noticed the snow under the trees pockmarked with holes about a hand's width wide.

"Somebody's out of hibernation, I think," Doc said.

"Somebody edible, I hope," Jacques answered. He had put hunger out of his mind, but with the prospect of food nearby, he felt almost irrationally famished.

With a whoosh, the something fell by Jacques, nearly hitting him on the head, punched a hole deep in the soft snow, and stopped with a sort of distant plopping sound. He looked up just in time to avoid getting hit by the next one.

"Bitterwood fruit, high-altitude version," Doc said, looking up.

"Hard to find down there," Jacques said, looking down the hole, hungry.

"Keep looking up," Doc said. "Come on now..."

He didn't have to wait long. A faint crack and rustle and he shuffled under the next one before it completed its 300-meter fall. With the expertise of an American-rules football receiver he plucked it out of the sky before it hit the snow. Wordlessly, they split it, cleaned it, and ate it immediately.

"Not too much more, right away," Doc said.

Jacques nodded. They caught a dozen more and headed back to the cave, somewhat lightheaded. They had survived the apastron winter and could get

back to the business of finding the shuttle, or establishing a settlement.

Doc rigged a tube from the shells of hirachnoid legs and some of their precious tape to get soup into Soob's stomach. They took turns watching him, feeding him, cleaning him, and finally, a week after the accident, he began to regain consciousness. But he wasn't really lucid and couldn't care for himself.

The snow melted and their sun was approaching its maximum size.

Temperatures climbed above freezing all day, snow melted, and the forest filled with bizarre critters and alien fragrances, as their sun approached.

Three days before periastron, they experienced a small earthquake, a thud followed by rumbling and groaning for about twenty seconds. Stones rocked around them, but nothing fell from the ceiling.

The next day, it hit 15 Celsius, and Helen went for a short swim in a small lake near the terrace edge. There were no other takers, but her joy in being bare and wet again, temperature be damned, made them all feel a bit warmer. They had a picnic in front of a low concave ridge of bare red rock by the lakeshore that sheltered them from the breeze and reflected the feeble sunlight on them. It was pleasant—even warm—there.

Helen picked up a rock and showed it to Jacques. "Geologically speaking," she said, "we're on a lava field between two volcanoes. I'll bet it slides down over millions of years and subducts just beyond the edge of the ocean."

"Then gets recirculated?" Doc asked.

Helen nodded. "I expect so, if this configuration is more or less stable over eons."

"What powers it?" Doc asked. "A world this small should lose heat faster than radioisotopes make it."

"Tides, maybe." Helen shrugged. "I wish I could do a simulation."

"There needs to be another world, farther out, to keep the orbit eccentric," Doc offered. A Neptune-mass giant, maybe."

"We haven't seen one," Collette said. "I think we would have."

Jacques nodded. "That's true, though I haven't looked carefully."

Helen said, "It might be dimmer than you think. Given the air pressure and temperature, I'm thinking we get half or something less of solar insolation here. But the primary is an M dwarf, so the visual light is maybe a tenth ... half of a tenth ... the amount of visual light one gets on Earth, and maybe a sixteenth of that at the nearest plausible giant planet orbit."

Jacques agreed. "Yes. A Jupiter equivalent would be something like an eightieth as bright. That's third or fourth magnitude here—visible but not really noticeable."

"Or," Doc said, "the planet could be closer to the star and too hard to see in the twilight."

Another, lesser quake interrupted the discussion.

"We can't stay forever," Jacques said, voicing what they all thought, staring up at the lava tube ceiling. "We're apparently still some distance from the shuttle. The season is getting on."

"We're about forty-eight kilometers above sea level now," Helen said. "I'm not sure it would be wise to winter at any higher altitude. What we could do is lay out supply caches at higher altitudes this summer, then make a dash up the following year."

"I should stay with Soob," Doc said.

"We should have two able-bodied people here," Jacques countered.

"We can rotate placing the caches," Collette offered. "You and me, Helen and me ... you and Helen."

Did she sound just a bit hesitant about the last pairing? Jacques wondered. Helen's approach to the three men, two women thing, was to spread her attention around more or less equally. Collette had not really tried to keep up; though she had genuine affection for Soob and Doc, she had taken a proprietary interest in Jacques. This flattered and excited Jacques, but the long-term implications also worried him. Taking care of human needs was important, he thought, but in their present circumstances "keeping it professional" might be the best policy. Helen was having none of that, of course. Still, he had no complaints from others. The discussion went on to the more comfortable subject of logistics and schedule.

The result of all this was that, on what he had determined to be periastron, midsummer's day, he and Collette set out, loaded up with as much as they could carry.

* * * *

Chapter 14

Jacob's Ladder

Up and down, up and down the crews went. They could go up three terraces and back in a day, and it generally took two trips to set enough supplies for a trip to a higher stage—though on the first two stages, they found they could stretch things by foraging. As summer drew to a close, they reached the tree line at forty-eight kilometers altitude, where it was only above freezing for a few hours a day. A hardy form of tanglegrass kept on over the next three terraces, and this was grazed on by a four-footed relative of the kangasaur about six times the size of an African elephant. It didn't have a prehensile nose, though, and made do with only one flat tusk growing from the lower jaw and a talented tongue.

These were far too big to think about killing, but the "hairadactyls" that tended them were another matter. These were eagle-sized and pigeon-brained, so the staging crews came back with as much as they took up.

The terraces changed; the higher ones were no longer sheer cliffs, but more rounded and slumped, often with natural ramps on which herds had beaten

paths from one level to another. Climbing cliffs became easier, but to make up for that, the slopes between them became steeper.

With the first chill of winter in the air, Jacques and Helen set out for the last foray until the next summer. They passed five depots, at fifty-six, sixty, sixty-four, sixty-eight, and seventy-two kilometers altitude—as estimated from the wrist comp's barometric readings—on the way up, overnighting in a tiny log lean-to on permafrost. They established a depot at seenty-six kilometers in a small cave on a rare outcropping of rock in a field of ice. By eighty-three kilometers the ice was gone; they'd found a small lava tube, however, and the rock below it was still warm. Wrapped in their batskin sleeping rolls, with a tiny fire guarding the entrance, Jacques felt downright cozy.

"What do you think?" Helen asked. "Only thirteen kilometers up to the one bar level." She snuggled up to him, as natural and unconcerned as ever.

On Earth, Jacques thought, thirteen kilometers altitude gain would be ridiculous for an up-and-back. But with the gravity being only about an eighth of Earth's at this altitude, and the terrain now simply rolling hills paved with smooth pahoehoe lava, it was probably doable.

"The oxygen partial pressure is going down," Jacques said. "It's harder to start a fire. We're still above Earth normal pressure, about 1,200 millibars, but oxygen partial pressure must be less than Earth's."

"Time to put the shipsuits on?" she asked.

Jacques thought about it. Their carefully preserved shipsuits had hoods, transparent in front, that could be sealed airtight. They were intended to serve as emergency vacuum suits on spacecraft. They could easily hold a few hundred millibars of pressure differential. They used the heat of their wearers' bodies to power the efficient nanosystems that removed carbon dioxide, but...

"They still need an air supply, and we don't have one. Maybe we can rig up some kind of bellows for next year. But we can wear them for warmth tomorrow, along with our batskins."

"Our Cube World language is evolving."

"Huh?"

Helen laughed. "You dropped the 'mega.' So I'm wearing 'batskins.' Its a better word."

"Yeah. If Gabe and company have made a similar discovery, they'll call it dragonskin, or something like that. Then we'll argue about it."

"If we ever see them again. Or maybe if our descendants meet theirs."

He tried to envision some future Cube World with two independent cultures, not speaking the same language, not having the same values, possibly even going to war with each other. The prospect made him shudder.

"No descendants. No. We're leaving this place. We're going to recover our technology, get robots working, make spaceships and a starship, and go home."

"That's a long-term dream," Helen said. "In the meantime, we need to settle in, build a town with enough room in it for children. We don't have robots, at least not yet. So we need more people." She grinned at him. "I've never been pregnant before. I'm looking forward to it."

He looked at her in abject horror. "With Soob down, we can't afford to have another person disabled."

She shook her head. "Then we'd best get on with it now before we lose someone else. I don't want to spend eternity being the last person on this planet. Yes, I've opened my tubes and I'm giving it my best shot."

"You're making a big decision for all of us."

She nodded and smiled cheerfully. "I didn't think I'd win a vote. You want to kick me off the planet? It's my body."

"You're not already..."

"Could even be yours. It's hard to tell just yet." She snuggled up to him.
"Don't worry. I can't get more pregnant."

"Hey, if you aren't I don't want to..." he said.

But she sealed his mouth with a kiss and biology took over.

Afterward, as afterglow faded into sleep, he wondered about man's ability to rationalize in the face of a determined womanly assault. Helen, he realized, was probably in charge here, preferring to lead from behind him, almost as Collette thought Leo might have led Gabe. In an era of genetic engineering leveling, she was still clearly smarter than anyone else in their small team, but her sexuality made some people forget her mind. She was Helen Athena, all-powerful, leading him on, enticing him. Then she became Collette and they lay down together. Then Collette became Ascendant Chryse and they decided to make babies and fill this planet with them. Then they could outvote Gabe Eddie and Leo. They needed to do it quickly before Leo stopped them.

Helen woke him up with a kiss before the dream reached its climax.

"Time to get going."

* * * *

They had their tiny camp packed before sunrise and set out upward under starlight, probing ahead of themselves with their flute plant walking sticks.

Antares alone provided enough light for them to find their way.

"It's much brighter than Venus, up here," Helen said. "I'd say about minus sixth magnitude."

"Hmm, maybe brighter than that. Almost like a crescent moon. I'll give it minus seven."

"Maybe. Lets say that's a maximum. Split the difference; since it's something like first magnitude from Earth, that would put it about 7.5

magnitudes, or a factor of 1,000 brighter than Earth. So it's thirty-some times closer, at least. Only five parsecs or so."

"About the same distance between 36 Ophiuchi and Earth," Jacques said. "You can barely see 36 Ophiuchi at that distance; this star casts shadows."

"I wonder what happens here when it goes supernova."

"Whoever build this place may have taken that into consideration," Jacques said, struggling to keep his mind on putting one synapse in front of the next. "Maybe they have predicted the date."

The terraces were gone, along with any hint of water. The lava field looked flat, except that they were bent over at almost forty-five degrees to the surface. Part of that was the slope of the mountain to the gravitational field and part of it was the wind they were slogging into. It was dry and cold, but Jacques thought it might change as day came. Footing was treacherous; the lava was covered with a loose grit that could slide underfoot, and thin spots in the lava could give way without warning, leaving one's foot dangling in a lava tube.

That said, they were able to maintain a fairly brisk pace without their packs, about three meters a second, Jacques thought. We're putting some distance behind us. He looked back over the featureless landscape and realized he couldn't recognize anything.

"Whoa, Helen. I can't see our camp!"

"Can you see the horizon against the mist?"

"Okay. Yes, I can see it. The bulge."

"If we've been headed directly uphill, the camp should be just below the bulge. We haven't gone too far to find it again, I think. But we should build a cairn here. A big one."

It was easier said than done. Portable rocks were hard to find in a pahoehoe field, but by stomping around they were able to collapse a small lava tube

and use the pieces of its roof to build an upright pillar. 'Upright' proved to be about thirty-degrees to the local slope, so they called it "the leaning tower of pieces."

They found they would hike upward for about an hour before it became hard to see a cairn, so that became their routine. As dawn came, they could see farther, but could also see better and move faster, so the hour interval remained about the same. Six cairns and an hour into the trip, they realized the ground was getting warm. An incongruous cloud lay ahead of them.

"Jacques, I don't think we should try to build a cairn here," Helen said.
"Look."

He turned to where she pointed and saw a piece of lava fall with a crunch into a new hole. A river of brilliant orange light shone through it.

They went quickly right until the steam cloud was no longer in front of them, and the ground seemed cooler to the touch. Some experimental stomping found them shards for the cairn.

Jacques found he was a little short on breath, and hooked his wrist comp to the solar array. The air near the lava surface was about zero C, but if he held the wrist comp high over his head, it recorded minus twenty-five. Atmospheric pressure was down to 998 millibars.

"Up ahead ... I think the lava field stops beyond that ridge."

Jacques saw and nodded. "I don't think we can go too much farther..." He stopped to breathe deeply. "...without more oxygen. I'd guess we're getting about half what we should, partial pressure around a hundred millibars."

Helen nodded. "Just a little farther. I want to see where the lava comes from."

They pushed on for another thirty minutes and arrived at the ridge. Above the lava was a smooth band of material that looked vaguely like concrete. Beyond that, uphill was a featureless plane of gray. He boosted Helen up over the "concrete" and she pulled him up afterward. It was absolutely flat.

"Is the shuttle still there?" Helen asked.

Jacques checked. "Yes, it has a somewhat stronger signal, but..." The reading was coming from directly in front of him, but he was standing at about a thirty-degree angle, which meant that the signal was coming from below Cube world's surface. "It's below us, Helen. Ahead and somehow below—a radio propagation trick?"

"I'm not sure, but I wouldn't think so." She pulled out the binoculars and scanned the horizon. "I can't see anything here. Maybe it's on the other side of the ridge. On the other face."

"How far to the ridge, do you think?" Jacques asked.

"Maybe a thousand kilometers. At five kilometers an hour, maybe two hundred hours."

"A week. We'd need enough oxygen for a week."

"Next year, if we can figure out how to store it," Helen said. "I want to stand on the ridge and look at both faces."

"While breast-feeding?" Jacques quipped, and instantly regretted it.

But Helen just laughed. "There will be time."

"Time to go home now."

He saw it out of the corner of his eye when he turned around to retrace their steps. It was just a bump in the otherwise geometrically smooth curve of the lava source ridge, an indeterminate distance away.

"Binoculars, Helen. Over there—a bump on the lava source ridge."

She pulled the binoculars from her belly kit, plugged them into the solar array, and sighted in on it. "It looks like a shelf sticking out of the plain. The top is probably level, gravitationally, the front, vertical. Like a dormer window. Four and a fraction klicks distant."

"We should go for it. It probably has something to do with this place." He stomped his foot on the surface for emphasis and almost lost his footing on the slope.

"We'd be finding our way home in the dark."

"We left that way."

They stared at each other. It was clearly more of a risk than Helen wanted, but Jacques weighed that against the potential for a breakthrough. It was a discovery that emphasized the differences in their attitudes: Helen for accepting a long stay and adapting to the world, Jacques putting almost all of his efforts into finding a way out.

"Okay," Helen said at length. "But let's go down to the lava source ridge—it's almost level on top—easier to walk on. It looks like the front of the structure is just a few meters back from the ridge."

They reached the structure well past local noon, but Jacques figured they still had seven hours plus twilight to return and find their camp. Helen was nervous, and he had picked up the pace as much as his oxygen-starved lungs would let him. The structure proved large—maybe twenty meters tall in front—and featureless as they approached from the side. But when they got to the front they saw a huge black rectangle about twenty meters by ten in the wall in front of them.

"I'd say it's a door," Helen said in wonderment. "A great big garage door."

They got a greater shock as they approached and it opened by simply vanishing.

* * * *

Chapter 15

Behind the Curtain

"And there we were," Helen told the assembled group, "inside this enormous, enormous room with great curving arches, huge pillars—of solid

diamond, I'd guess—catwalks the width of airplane runways, huge machines rolling around without making any sound whatsoever."

"It was lit inside?" Collette asked.

Jacques nodded. "There were point sources every few kilometers, I'd guess. They looked like stars, but much brighter. In the distance they kind of merged into a general glow. We only took half an hour inside—it was too cold to stay overnight and we had to get back to camp. But it looks like there's a road through to the other side of the ridge. Which is where my readings indicate the shuttle is."

He looked around the group. Soob nodded and smiled at him; he wasn't able to speak or walk without assistance, but at least the higher functions of his mind hadn't been too badly damaged by his near-suffocation. Doc said he was getting better every day.

If they had all been healthy, they might have tried for the other side immediately, but they didn't want to do that with only two people, gone into an unknown environment for the entire winter, and they couldn't bring Soob in his present state. So Eagle's Nest was getting ready for their second winter. Provisions were piled high in the ice cave. Partitions of flute plant mats broke the wind through the cave and gave them private bedrooms.

"Did anyone, or anything, notice you were there?" Collette asked. "Seems like pretty loose security to me."

"Whatever guards the door apparently didn't see us as a threat," Jacques said. "The way it just vanished ... and it was solid before. I touched it."

"It could be some form of programmable matter," Helen said. "People have been working on it forever. Send it one signal and it's a solid wall, send it another and it's just dust in the air."

"Which we breathed," Jacques added. "Without, apparently, any ill effects."

"So you have alien nanites running around inside you," Doc concluded.

Soob grunted and reached for his slate, wrote and handed the slate to Collette.

"All of us since arrival. Place is managed!" she read.

"Okay," Helen said in a loud voice. "Whoever you are, you can stop playing with us. We have better things to do with our lives."

There was, of course, no response, and the group had a nervous laugh.

* * * *

The winter passed, if not comfortably, with much less difficulty. They had enough food. Jacques rigged a system to keep the top entrance open, and they even managed a few trips to the first two stage camps, bringing more provisions and creating more living room.

On one trip, they saw a megabat crash into the snow. Why it did so, they couldn't guess, but its carcass yielded a fresh supply of batskin and more meat than they could eat in years. What they brought back to the cave with them became frozen steaks and jerky for next summer's expedition.

Finally the snow melted and Jacques finished his carved stone marker, following their names with: Eagles Nest. Days 72-195

They had to travel light, of course, and left countless things they had made over the two winters. They told themselves they would be back again someday, knowing it would be unlikely. They imagined tourists going through their cave in some ten thousand years, looking at their carvings, primitive furniture, stone kitchenware, and all.

Helen had tears in her eyes as she left. She had hoped to raise a child there. Soob touched her arm. He walked well enough, now, but still could not talk. What memories Eagle's Nest must have for him! But with last looks back, they were on their way, with full packs, along a now well-beaten trail to Tree Line Camp.

They reached the maintenance entrance a week later, quite prepared for it to not open for them. But it did, and in they went, with Collette, Doc, and Soob making appropriate sounds of wonder at the network of roadways, braces, and catwalks between great vertical tubes that climbed from far below to far above. Here and there, Jacques thought he could see robots moving around on huge catwalks on the inside of the mountain surface, many kilometers away. The place was obviously being actively maintained.

They had, nominally, forty days' provisions with them; Jacques thought two weeks would get them through the 1,000 kilometers to the other side. If they found no exit at the other end, they could conceivably retrace their steps on short rations. Shortcut though it might be, it was a long, cold, hard walk through a complete desert. There was nothing to be done about disguising their presence and they had to litter the clean roadway with hirachnoid limb shells and worse.

On the flat, hard surface, however, they found they could half walk, half jog in a kind of long loping stride that saved their feet and ate up the kilometers. They took turns holding Soob's hand—his legs were strong enough, but his coordination wasn't fully back yet. It was a bit embarrassing for him, but he bore it with good grace. Going by the increase in signal strength, they managed between sixty-one and seventy-two kilometers the first day, and between fifty-five and sixty-seven, the second.

On the first break of the third day, Helen announced, "We're going downhill!"

They all looked at her. The road had seemed level when they started, but now, though it was hard to tell in the low gravity, they indeed seemed to be leaning back a bit.

Doc groaned. "Of course, of course. This is a brace as well as a road. To be in compression—not supported by the vertical members, it has to come closer to the planet at its center than the ends—as an interior buttress, it's almost straight."

"Downhill!" Collette exclaimed, "Then we'll need to push it a little more now to compensate for being slower later on. But we'll get more oxygen as

we go lower."

So they took to loping a little faster—almost a low-gravity jog—and covered around eighty kilometers in two seven-hour sessions that day. The next day was close to eighty kilometers as well, but the apparent downward slope gradually lessened, and by the fifth day they were more or less level and probably approaching the lowest point of the road. From then on, it would be uphill.

Soob's balance was improving every day, and by the time they started going uphill, he'd felt comfortable without a hand-holder, though he kept his flute plant walking stick.

They made camp on the fifth day on the road, in good spirits. They each carried a double-thickness batskin sack.

On the sixth day, they noted that their road was joined on the right from below by an arch, the top of which was another road.

"That looks like a constant-radius road," Helen said. "With its own support system. It's not hanging from a shell support column. It would be nice to avoid the climb and end up somewhere that wasn't an Antarctic dry valley."

Collette shook her head. "How would we get to the surface? It's covered with rock. We'd be risking too much."

They were about to give up when Jacques remembered the network of catwalks just under the surface that he'd seen when they entered. "If we can't get out, we can climb up on the inside. We'll have saved enough time for it, I think."

"Just barely," Helen said. "We'd be putting our contingency plan in jeopardy."

"But if it works," Doc said, "we'd save several days and end up where we can forage. We'd be in much better shape."

"The shuttle is powered and active," Jacques said. "We must assume someone is using it. We must also assume that someone saw us go in the mountain. If we come out at a different altitude, that could be a surprise. It could be our only advantage."

"We were put here by an ideology-blinded fanatic," Collette said. "The bad guys aren't usually geniuses—we need to be wary, but let's not fail to give them a chance to make a mistake."

"I think we should give it a shot. What do you think, Soob?" Doc asked.

Their hunter smiled and pointed down the curved path.

* * * *

Longer and gravitationally level, it took them six days to traverse the constant radius path. It ended in a T intersection with a straight catwalk, four meters wide, on the inside surface of the mountain. Jacques could see nothing that looked like an entrance.

Soob grunted and pointed above them. A tube hung down from the inside surface of the mountain, like a stalactite, with what looked like a flat, black circular face. It was about ten meters above them, and there was no ladder. A robot on top of one of the big machines that rolled around the catwalks wouldn't need one, of course.

So near yet so far, Jacques thought. But then he spotted an interior catwalk passing near the upper end of the tube.

Jacques imagined a line running from that catwalk to their catwalk at just the right angle to touch the tip of the downward-projecting tube. He quickly explained what he had in mind to the group. They had two long lines, and tied them end-to-end. Jacques found a brace that led to the upper catwalk and pulled himself up, hand over hand, careful not to look down until he was securely on the walkway. There were no rails, of course, for infallible machines.

But the catwalk had to be supported. He found a brace projecting from the inside surface of the mountain and managed to loop the line around that, then threw the other end down to Collette. She walked the end of the line along the lower catwalk until the middle of the line touched the end of the projecting tube. Secured with a loop of tanglegrass rope, Jacques wrapped his legs around the line and eased himself down, sloth-style, until he was below the tube.

It was about a meter wide and remained resolutely closed. He put a hand on it and pushed. Solid. Just for the hell of it, he shouted “Open!” at it. That did nothing.

Something had to make it open. The other door had responded to their presence, not some external computer demand. That bespoke a distributed, semi-autonomous systems approach to Cube World—far more efficient and robust than a top-down control pyramid. The door-opening trigger should be local.

Maybe they would have to wait for a maintenance robot to roll by. That could be a long time—things seemed to last in here. Or maybe they could simulate one.

“Everyone!” he shouted. “I want you to walk directly beneath me and jump up and down. I’m hoping there’s a mass or weight sensor on the catwalk.”

“Say again,” was Collette’s distant response.

He yelled again, louder, and got an okay back. The group walked beneath him and, in a surreal sort of dance, jumped up and down in time. Nothing happened.

In frustration he slammed the palm of his hand at the surface above him.

And it vanished, rewarding his effort with a shower of dust. There was a circular shelf a few centimeters wide around the opening. He grabbed that with one hand and held on, hoping that would keep the door open, and then pulled his head inside. Inside the tube was a robust skeleton of truss work

and tracks; apparently some fairly heavy equipment could use this passage. Boring machines? If so, he hoped they had done their job.

"I'm in!" he shouted down to the rest of the party. He used a length of green twine to tie his line securely to the inner framework of the tube. In the low gravity, the rest of the group would be able to pull themselves up, hand over hand. But first he needed to make sure there was an exit. "I'm going to see if there's a way out." He estimated the length of the tube. "I'll be back in about an hour."

Jacques climbed up the inner bracing of the tube. Up and up, he went, mostly by feel. Just before he thought he would need to drop back to the opening to make his self-imposed deadline, he emerged in what appeared to be a lava tube cave, not unlike the one they'd used for Eagle's Nest. He could feel a slight breeze and smell fresh air.

* * * *

The cave exit proved to be a three-kilometer scramble over rocks in the dark. About halfway, they encountered a stream and a hundred meters or so down from that, enough dry silt that they could lie down. With nobody making an objection, they simply made camp there and slept for twelve and a half hours. Feeling optimistic, they decided to make breakfast double rations, and didn't start out again until they all felt ready.

Helen was in the lead as they reached the mouth of the cave. She scrambled over some rocks that partly blocked the exit and vanished from Jacques' view.

"Oh my God!" she yelled from somewhere outside. "They're alive!"

* * * *

Chapter 16

The Other Side of the Mountain

Everyone else started forward, but Collette held them back. "Weapons," she said. "Whatever we have."

Jacques and Collette strung their bows while Soob and Doc pulled the covers off their spears.

"Helen," Jacques yelled, "are you okay?"

There was a pause. "Yes. No danger so far. I don't think they've noticed me." The last was choked out in a kind of hysterical giggle.

The rest of the party climbed out, one by one. Little rock was visible in a forest of plants that had stems like blackwood trees but had huge, fleshy, triangular yellow leaves. Over them, a sparse canopy of trees of some unimaginable height dominated the landscape. Some of these were vaguely palmlike while others seemed to be more stalklike, with only a hint of foliage around the upper stem. They were spaced far apart in the near field but merged in the distance to look like a solid line of wood. They swayed in the soft breeze.

Rather, some of them swayed, mainly the ones absent luxuriant palmlike crowns.

"Oh my God!" Collette echoed Helen.

"I don't think that's possible," Helen said. "Even as I see it, it can't be! The heat-rejection problem..."

Confused, Jacques scanned around at the distant waving stalks and watched one of them touch the crown of a leafy tree and, apparently, come away with some of the leaves. A sense of disquiet rose within him. Plants feeding on other plants?

He scrambled up higher on the rocks of the cave mouth to where he could see down slope over three terraces, a distance of about eleven kilometers, at least, on the other side of the ridge. If that held here—he was looking at trees almost two hundred meters tall.

He craned his head up to find one of the nearer stalk trees and started to follow it down.

It moved as he did so, not swaying, but moving laterally with slow, infinite patience. A massive leg swung ponderously clear of undergrowth forest, tall as any of the triangle-leaf trees.

"Oh my God!" he said.

The beast, for that was what it was, moved with what seemed a glacial pace, an illusion of scale, he realized. It may have taken seven seconds for that leg to swing forward, but the footprints would be something like eighty meters apart. He could not have outrun it. The foot set down gently, not thunderously.

"Its head must be 160 meters high," Jacques said, a touch of awe in his voice.

"I'm not sure it's a head," Doc answered. "It may be more like a trunk with sense organs. I think that bulge above the shoulders is more likely the true head."

The skin on the creature's sides seemed loosely hung, like overlapping drapery. As it moved, there was a whooshing sound Jacques could hear, even a third of a kilometer or so away.

"It has gills?" Helen said softly, in wonder.

"Exhaust," Doc said. "It's about eight times the dimension of a large sauropod dinosaur from Earth's past. Everything else being more or less to scale, it would have some 500 times as much volume and mass, but only..." he laughed at the irony of "only," "...about sixty-some times the surface area with which to reject heat. It must blow a tremendous volume of air through itself with every step."

Soob scratched on his slate and gave it to Helen.

Don't/do want see what eats it.

Finding what *they* could eat was the first order of business. Nothing looked familiar to Jacques, or rather some of it did; the grasses were uncannily terrestrial looking. The triangle-leaf trees had a pulpy pumpkin-sized fruit that was either out of reach, or hit the ground with a forceful splat even in the low gravity. They found a bamboolike middle canopy plant; young shoots were an acceptable substitute for flute plant, but the fernlike fronds were inedible. In sunny patches of ground, they found a low plant with leaves shaped like pentagonal snowflakes.

Making a virtue of necessity, Doc made a kind of pudding of fall-mashed triangle-leaf tree fruit. It proved to be a good diuretic. Cooking it didn't improve matters.

The white part of the grass roots could be nibbled, but it would take a huge amount of grass to make a meal. None of the leaves would stay down.

"We're just damned lucky we haven't seriously poisoned ourselves," Doc said on the morning of the third day. We need to think about going back."

"We'll be starved by the time we get there," Jacques said.

Doc nodded. "Uncomfortable to be sure, but we should survive. Another day or two and one or more of us might not make it."

"We can try for the shuttle now," Jacques said. "At least take time to get a fix. It may be near."

The shuttle, if they could gain control of it, would solve the food problem. But taking any time away from exploratory foraging now could put them in severe difficulty later.

Soob wrote: "Go for it."

"Come on, Collette, let's find some food," Helen said.

Doc patted Jacques on the back and went with them.

Jacques and Soob found a gap in the tree cover where sunlight fell and set up the solar cells and plugged in. The shuttle signal was very strong. He

looked around and saw trees and a few "dinotowers."

"It's around here somewhere, Soob. Maybe we can get one of those guys to tell us," he joked, pointing at a dinotower a few hundred meters away.

Soob nodded, seriously it seemed, and motioned to Jacques that he wanted to go to the dinotower. Soon they were at the rear leg of one of the monsters. Soob tried to climb it, but the thick skin proved impossible to grip.

Jacques went to the tail and back along it until he reached where it rested on the ground. It was as thick as he was tall, but with measured jump, he was able to land on top of it. Soob followed him. They began walking up the giant's back; its head was actually lost in a low mist.

"I hope it doesn't decide to swat a fly, just now," he said back to Soob.

Soob gestured for him to keep moving, faster, and Jacques picked up the pace.

The huge body moved under them as they reached its hips and they fell, spread-eagled on its rump. Jacques looked over to Soob, who looked back at him, wide-eyed. He pointed to something behind Jacques.

Jacques turned and saw a huge head descending from the mist. It was vaguely frog-like, and almost two meters wide, with eyes as big as basketballs, and a small central crest. As it came toward him, the mouth opened, revealing broad, sharp teeth that looked like human incisors as much as anything.

He thought about jumping, but they were too high—even in the low gravity, the fall would lead to serious injury. He tried waving at it.

"Hi."

The head stopped. He could see the long neck now; the mists were clearing. The huge eyes focused on him. Scale matters, Jacques thought. While the head in front of him was a ridiculously tiny part of the dinotower's bulk, it

probably contained a brain several times the size of the one on his shoulders.

Jacques tried to pantomime looking. Soob got up and joined him. The creature watched them for a while, then laid its head on its back in front of them.

"I think," Jacques said, with more than a little awe in his voice, "that we're being offered a ride."

He and Soob hopped up on the broad, flat head and hung onto the narrow crest as the dinotower's head whooshed back up through the mist to its usual height.

Then, with a gentle rocking motion, the beast began to move out toward the edge of the terrace, about as fast as a man could run, in Jacques estimation. In the denser Cube World air, this made for a significant wind of passage, and he had to hang on tightly.

They hadn't gone far when the head began to drop down through the mists again, down and down, like a huge, fast elevator. Suddenly, in front of them, about fifty meters through the trees, was the shuttle.

"It must have seen men before, with it. It's putting us back where we belong," Jacques said.

The head reached ground, and they hopped off. For a moment, human and dinotower stared at each other, then the dinotower raised its head through the clouds and began to glide back to its feeding ground.

Jacques turned his attention to the shuttle, a big, blunt upside-down ice-cream cone, its gray lines blending in with the triangle-leaf tree trunks like it was designed to do so. Soob immediately gestured for him to get down. Of course. If they could see it, it could see them, and it probably had instructions of a kind not anticipated by its AI programmers. Jacques thought furiously. No, there was nothing to do but try contacting it and go from there. It would better be a collective decision, but there it was now and

it might fly away. He touched the transmit icon on his wristcomp screen and began talking.

"This is Engineering Officer Jacques Song. We have..."

The shuttle sounded a warning tone.

"Duck! Now!" Jacques said as he pushed Soob to the ground. "It's lifting off!"

With a roaring cascade of exhaust, the shuttle leaped skyward and was already hundreds of meters overhead and shrinking as the wave of hot air rolled over them.

Jacques stared up, helpless. Then he collapsed onto a log and put his face in his hands, tears flowing freely. Everything over the last few months went by in his mind—the parrot-beaked fish, the rescues, the split up, the escape from the fire, the winter in the cave ... all the work, all the effort. Gone. All his efforts fruitless, leaving them with the prospect of retreat, starvation, and living out their lives as savages.

Helen may think that worthwhile, Jacques thought. But he wasn't sure he did. He didn't think he could face an eternity of the kind of labor and striving it had taken them to survive for the last three months, and if he ended his existence now, there would be one less mouth to feed.

Soob was trying to get his attention, shoving his slate at him. With a groan, Jacques took it.

Not out of range. Keep talking!!

Jacques hurriedly turned back to the wristcomp, pointing its directional antenna at the tip of the ascending contrail, said everything he planned to say, and added, "We are at the end of our food supply. If you leave us you may be responsible for human deaths." If there was anything left of the higher functions in its AI, Jacques thought, that should do it.

The shuttle did not deviate from its upward path, and its contrail ended where it left the atmosphere.

Then Jacques looked down at his wristcomp screen. The “message received” telltale glowed. Pure automation, he supposed, but one microscopic step above complete hopelessness. At least he had the energy to trudge back to camp with Soob, following the swath cleared by the dinotower.

When they got there, Helen, Collette, and Doc all had big grins on their faces, and their arms filled with big thick roots of some kind. Presumably, that meant a respite from the starvation part of his bleak scenario. He wanted to go back into the cave and lie down and leave the explanations to Soob, but, of course, that was impossible. He decided on the short and sweet version.

"We found the shuttle. It flew away. I'm not feeling so good right now, I just..."

"Try some of this and you'll feel a lot better," Doc said, laughing.

"It's really ... I can't describe. Just wow!" Collette said.

Despite the near-freezing temperatures, Helen discarded her clothes and started dancing, holding a morsel of the root out to Jacques. "Come on, lover boy, cheer up," she said.

Collette was going after Soob, in a somewhat less spectacular, though equally determined manner.

Why not? Jacques thought. Why the hell not?

Because if they all went crazy, they would all die, not just him. He knocked the piece of root out of Helen's hand.

She looked confused. "Jacques, honey, it's all right. We're just a bit giddy. We're okay. We're due for a party."

"You're intoxicated. You're not thinking right," he said, suspecting that reason would be futile while they were under the influence of whatever it was.

Something went crunch in the nearby underbrush. Jacques turned and found himself facing what appeared to be a close cousin of *Tyrannosaurus rex*, except it had a beak instead of teeth, and four tiny arms instead of two.

It didn't seem to know what to make of them. He grabbed his flute plant staff.

"Soob, get everyone in the cave," he yelled, as he tossed his bag of electronics to the hunter and stood to face the beast.

Everyone was not going to the cave. Helen was behind him saying, "Hey, that's a big dinosaur, isn't it? Maybe it would like some candy. Give the dino some candy."

"What it would like is you," Jacques snapped. "But it isn't sure yet. Get in the cave!"

"You're no fun! Hey, Soob, where are you going with my roots? Come back here."

Jacques risked a quick look back. Soob had grabbed all the roots and was taking them into the cave. The other three, complaining, were going after him. Nothing wrong with that part of Soob's brain, Jacques thought.

The "tyrannoparrot" began rocking back and forth, looking at him and the people disappearing into the cave mouth. Why had it not attacked? Maybe, Jacques thought, with his staff, he looked approximately like something it hadn't seen yet that was dangerous, poisonous, or both. They must have stood there, tiny human staring down a three-story monster, for almost fifteen minutes. Then, abruptly, the tyrannoparrot turned and strode off into the forest.

He had a feeling of *déjà vu* about this, something he'd read or viewed. Lewis and Clark. One of them had faced down a grizzly bear in the middle

of a river with a staff like his. Someday, he told himself, he should find out why the monster had spared him. But for now, it was interesting to note how the adrenaline had set aside his depression. When it came down to it, in spite of everything, he still very much wanted to live.

He joined Soob at the cave and they started a fire at the mouth. The other three had fallen into a deep sleep, so there were no protests as into the fire went the big thick tubers. The gentle breeze out of the cave mouth kept the fumes from going in, while Soob and he pulled shifts to keep the fire and their friends alive through the night.

* * * *

Jacques awoke to find Doc poking around the fire.

"Doc?" he said, fearing the worst. He put some more wood on the fire.

"We should have a sample," he said. "Imagine a raw potato, but already a little buttery. The drug affect didn't set in until half an hour after ingestion. I suspect it's a chemical given off by a bacterialike bug and not the root itself."

He finally came up with a short segment of charred root and handed it to Jacques.

"Try a very small piece. We'd each eaten maybe a hundred grams, and if I'm right about the bacterium, the fire will have killed it and degraded the toxin. But, I'm not sure I trust myself."

Jacques held the charred morsel in his hand, feeling very uncertain.

"It is the only edible thing we've found here," Doc said, looking down at the ground. "We don't have much choice, and, by the way, thank you for saving my life again." He said the last in a whisper and with a slight bow.

Jacques touched him on the shoulder for a moment.

Then, with a wry smile, Jacques took a bite of the root, still warm from the fire. It did taste like buttered potatoes, and, irrationally, he wished for some

salt. Or maybe not irrationally. They probably weren't getting quite enough salt. He swallowed and waited to go crazy.

"Half an hour, you say?"

Doc nodded.

Jacques unfolded their little solar array, plugged in the wrist comp, and sat down in front of the fire. "Do you remember what I said about the shuttle?"

"It flew away. I'm sorry I wasn't in a state of mind to appreciate that news, or, maybe I'm not so sorry. Pretty disappointing, that."

"Yeah."

Doc shivered and covered himself with his batskin sleep sack, even though the fire was going strong. "We'll need to move to a lower altitude for a permanent camp."

"Or go back to where we know the territory better."

Doc nodded. "A little easier, if cooking this root works."

They continued to talk until Collette, Soob, and Helen joined them.

"I wish I didn't remember everything so well," was Helen's only comment.

"We need a name for this stuff," Collette said. "It should be a warning, like 'crazyroot.'" "I'll go with crazyroot," Jacques said, "and, by the way, am I crazy yet?"

"We accidentally cooked some, and he's tried that," Doc explained.

"You sound okay to me, Jacques," Collette said.

Soob tried to talk. It came out something like, "Yuh-uh," but those were his first words since almost suffocating in the snowdrift.

Doc cut another piece off the cooked 'crazyroot' and popped it in his own mouth. "Okay. I think it would be best if Jacques and Soob gather the next batch. I don't want to be tempted. It felt good, way too good."

"We can't stay here," Helen said. "I mean, the temptation would always be there."

She wasn't one to resist sensual temptations, Jacques thought. But at least she knew herself.

"I wouldn't want to raise children with that kind of temptation around, either," Collette said. "And I think the megabats are probably easier to deal with than the tyrannoparrots."

"There are four other faces on this cube that we haven't seen," Doc said. "It's probably premature to say which is best for us."

Soob grunted and tried to speak, then shook his head and pulled his slate from his shoulder bag and scratched, *R we welcome anywhere?*

Jacques thought about the huge maintenance operations in the hollow ridge behind him. This immense, self-perpetuating operation had to be controlled by a high-grade artificial intelligence.

"I think so. Of course, something is clearly in charge here. But it has made no effort to communicate, to wipe us out, nor to help us, at least as far as we can tell."

"Maybe it's not aware we're here, like you're not aware that a specific microbe is on or in your body," Doc said. "Our impact, so far, could be well under its threshold."

"I don't know," Collette said. "If we made something to manage this, it would be very concerned with biological contamination."

Helen laughed. "We've become like Gabe. He knows there's a god, or at least says he does, but what does it want, what does it expect of him? When it doesn't say, he makes up answers or quotes others who made up answers."

"Then that becomes doctrine, regardless of any later evidence," Collette said.

Doc chortled. "People like Gabe have evolved an ability to withstand a level of cognitive dissonance that would be fatal to ordinary mortals. We may make up answers, but we test them."

Soob scratched furiously on his slate. "People make this? Four hundred years."

Jacques shivered. Yes, a thousand years in time, but only six hundred or so in space; the *Resolution* could easily have been passed by human descendants during its long slowdown from relativistic velocities. Before they left, the potential of self-replicating robots to make megastructures in decades or even years had just begun to be used: the solar power stations of the interstellar transport complex, the Venus sunscreen, and the beginnings of the Mercury sphere. What could they do in this age?

"They may feel we aren't ready to handle the shock of what humanity has become," Helen said quietly. "They could be right."

Collette shook her head. "So they let us starve to death? That doesn't make sense. Anyway, we need some food." She began poking around the fire, apparently hoping to find some cooked crazyroot missed in earlier searches. "We'll also need weapons."

Jacques wondered what sort of weapon would deter a tyrannoparrot, but after reflection decided something would be better than nothing. They made long spears, sharpening the ends of the "neobamboo" with a diagonal cut and fire-hardening them. Then they set out.

A couple of hours later, burdened with roots and almost back to the camp, Jacques thought he heard a distant hissing noise, something between a waterfall and an angry cat. It seemed to be coming above him. He looked around. They were too high and too cold for something like a megabat, he thought.

Helen was looking too. "The shuttle! Everyone, the shuttle is coming back!"

* * * *

Chapter 17

Lost and Found

"Captain Song," it said as they approached, "I have determined that you are correct. As senior surviving crewmember, command devolves on you. It was necessary to preserve life, get confirmatory data, and preserve the ignorance of the unauthorized users to carry out one more scheduled supply run. The *Resolution* shuttle *Fortitude* is now under your command. I will need your assistance to recover much of my memory."

Jacques looked at the shuttle, then back to Helen and the others, dumbfounded. Less than a Cube World day ago, he had hit rock bottom, contemplating suicide. Now, he had apparently succeeded in everything. Oh, there was still a lot to do, decisions to be made, questions to ask and have answered. But with the shuttle's replicator, they could do everything they wanted.

"We'll be on that in a moment," he said, softly, then turned to the party. "I, I have a hard time believing this, but I think we're over the hill here."

"We can move to better quarters, anyway," Doc said.

As it sank in, Jacques found himself emotionally unprepared for success. It was as if all the stress of the last few months had spilled out and left him as empty as a deflated balloon. He collapsed onto a nearby log, eyes moistening. "I just want to go home. I want to go home."

"Jacques," Helen answered. "We can't. Home is a thousand years in the past, sixteen hundred counting travel time. Whatever the Solar System has become, it's not home anymore. That's only in memory."

She was right, of course. They had all signed up for what was to have been a significant hunk of time displacement to go on the initial mission, but that was tiny compared to what they now contemplated. She led the way to the shuttle lock. "Permission to board, Captain?"

* * * *

The shuttle had been hobbled. The wireless data links it used to communicate with its robots had been removed. Its primary memory slots had been vacated, except for one card; clearly a "Trojan card" inserted by the saboteur. What the saboteur apparently did not know was that there was a backup executive agent program in the engineering node, a limited AI but with the basic security protocols and Asimovian restraints. Absent a higher authority, this had followed the primary card, but Jacques' statements had created a conflict, eventually resolved in Jacques' favor.

The shuttle had been used by Gabriel Eddie, Leo Suretta, Arroya Montez, and Evgenie Malenkov. No surprise there, Jacques thought. Gabe and eleven others had been revived and assigned to shuttles by the ship before its final crash into Cube World's atmosphere. They were supposed to recover CSUs that survived atmospheric entry—but that mission had to be postponed. The Shuttle *Fortitude* had come down on another face of Cube World. It had taken Gabe some time to discover Jacques' group—which he'd done from the air.

"According to the log, he'd only just arrived when we met him," Collette said. "The Robinson Crusoe get-up was a ruse."

Doc nodded. "When he found us, he kept the shuttle a secret, apparently seeing an opportunity to become the dictator of a new accidental colony. He knew there was no danger in staying at New Landing—no wonder he was so adamant."

"If he'd only just gotten there, he couldn't have killed Ascendant Chryse," Helen observed.

Jacques stated the obvious. "We're missing a lot of information."

After mining what data they could from the saboteur's card, Jacques replaced it with a set of backup cards, in storage since before the *Resolution* left the Solar System. Then he went to work on the wireless system, and after an hour of testing, locating replacement parts, and plugging them in, he was rewarded by a small crablike maintenance robot showing up, ready to work.

"Soup's on," Helen's voice rang down the narrow corridor to the engineering section. Jacques left the cleanup to the robot and pulled himself up the passageway.

By twenty-third-century starship standards, the shuttle's berths, tiny mess, and compact flight deck were cramped and utilitarian. But compared to how Jacques and company had been living for the last six months, they were the height of luxury.

Everyone but him had cycled through the tiny shower and gotten fresh shipsuits. Even Helen was wearing hers—she hadn't left all the cooking to the robotics.

"Go have your shower. It'll wait ten minutes," she said, and he complied. The head was an oval cross-section marvel of spatial efficiency, with an improbably tiny combination commode and washbasin in one end and the shower in the other. He removed his clothes, stood on the grate, and let the doors close around him. Almost immediately, a warm hurricane descended on him, followed by a short needle spray that emerged from every direction, reached every crevice of his body, and was quickly sucked away. The cycle repeated twice automatically, and he had it repeat again. He emerged clean, dry, and somehow feeling both stimulated and exhausted.

When they all got together, before they dug in to a meal of real replicated Earth food, Helen said, "We've been really lucky. I'd like to do something to commemorate this. Maybe sing?"

Soob quickly scratched something on his slate and handed it to Helen.

"Amazing Grace," she read. "Very appropriate, I think. Do we all know it?"

Everyone nodded, and they began, led by Doc's deep baritone. Somehow, while he still couldn't talk, Soob was able to sing along, surprising himself as much as everyone else. Afterward, however, he still couldn't talk. They held off business until after their meal of gyros and white wine; everything replicated, of course, but it tasted wonderful. Finally they sat and stared at each other.

"We still have a lot of work to do," Helen started. "We need a base of operations. We need to decide what to do about Gabe's group."

"We have a huge crime to deal with," Collette said, "dozens of dead or deprived..." She had difficulty finishing the sentence. "...of the lives they knew."

"Whoever the conspirators are, there are innocent people with them," Jacques said.

Helen looked as hard as he had ever seen her. "Just how innocent are the ones that chose to stay with Suretta and Eddie? Misogynist power-hungry charlatans. Anyone should see that. And how do you have a trial in a community this small, especially when you're a minority? They made their choice. Leave them to live, or die, with it."

"We haven't determined who was controlling the shuttle," Collette said, "nor if he, or she, or they were the saboteurs, nor if a saboteur was who murdered Ascendant Chryse. We probably need to do that, if we can, before contacting the rest of the survivors. And we need to keep up the shuttle deliveries of critical nutrients to avoid suspicion."

Doc chuckled. "Perhaps we simply see who's been meeting the shuttle."

Soob wrote, "Secure base first, take risks second."

Helen nodded. "It will be risky to make any deliveries at all; whoever did this may have a contingency plan."

Collette shook her head. "There is some risk, but to effectively execute all of them? That's more than I want on my conscience. Besides, I want to

know what happened."

"How much time do we have?" Jacques asked. "When is the next resupply flight?"

"Resupply flights have been at random intervals, generally from six to ten days," the shuttle AI responded.

"Who orders them?" Collette asked.

"The identifier is: A5428C42."

"We need to see one of those meetings," Collette said. "I wonder if the security means they are guarding against us or each other."

Helen laughed. "Somehow, I don't see Gabe anticipating that we'd tunnel through to where he's been hiding the shuttle."

"It might not be Gabe. Leo's more the type. Or maybe even one of the women, staying in the background. What are you thinking, Jacques?" Doc asked.

He was thinking they needed more time and less risk. "We could set up a minimum stand-alone facility at Eagle's Nest—we can get there if things go sour with the shuttle. Then let things proceed until we have more information. When we know what we're dealing with and have a good fallback, we can decide the next step."

"To Eagles Nest!" Doc said.

"Not so fast," Jacques said. "If I was able to track the shuttle's position, whoever's been using it will as well. We shouldn't use it for transportation until we're ready."

* * * *

It was a good concept, Jacques thought, but it gave them only about five days to replicate the replicator. They stayed at "Tunnel's End" for the time being while the shuttle essentially "printed" three-dimensional objects on a

five-by-five centimeter stage. The device itself, with its power supply, input matter processor, cooling connections, and so on was almost half a cubic meter. That had to be “broken down” into five-centimeter cubed sections, and it wasn't designed that way. The AI helped, but it was well into the third day before the parts started coming out.

When the call came on the afternoon of the fourth day, it caught them unprepared.

“A5428C42 has directed a flight,” *Fortitude* announced on Jacques' wristcomp; only he and Soob were in the vicinity. They quickly helped the robots get their things off.

The *Fortitude* came back, a day later, to everyone's relief, especially Helen's.

“I got my necklace back!” she beamed.

But when they played back the recording of who was meeting the shuttle, they got a surprise. It was a tiny kangasaur that came aboard and picked up the bottle of nutrient powder from the replicator stage, then hopped away.

“Trained?” Doc speculated.

“Cute, anyway,” Collette said. “I think it's a robot. Nobody would notice it, and our perp wouldn't need excuses for occasional long absences. But a robot is unlikely to command the shuttle to do anything different, nor notice that the Trojan memory chip is no longer in charge.”

“We need to proceed quickly; they're bound to be suspicious, eventually.”

After two weeks working with the newreplicator, they had a ten-kilowatt boron-proton power plant and a collapsible electric cart to make the trip back to Eagle's nest in a couple of days. Knowing what to look for, they found a vertical maintenance access to the Eagle's nest lava tube.

Another week gave them a second working replicator with a larger assembly platform at Eagle's nest. Tools, sanitary facilities, beds, and small

robots soon followed.

On the fourth return of the shuttle, they felt ready to visit the New Landing community. Soob got a dinosaur-capable tranquilizer dart gun. Collette got herself a complete police officer's kit. Everyone else got tranquilizer flechette pistols.

The call for the next shipment of nutrient powder came, and they all got aboard.

The view of Cube World from space was spectacular and bizarre. At the high point of their trajectory, they could see three faces, each with green, blue, and green concentric circles at its center.

"You're not wearing your necklace," Collette said to Helen as deceleration began. "Edith would love to see it!"

Helen beamed. "I'll get it right now so I don't forget it."

At a quarter gee, the deceleration provided no real hindrance to moving around the shuttle. They were almost down when she reemerged on the control deck.

"I couldn't find it," she said, deliberately. "Must have left it at Camp Fortitude."

Camp Fortitude? Jacques was suddenly alert—they'd never named any place Camp Fortitude.

He turned and looked at her. Her eyes were wide and her face was grim. She raised a finger to her lips. Helen hadn't left her necklace anywhere but on the shuttle. On the shuttle *Fortitude*.

Which wasn't this; there were three to start with—identical, of course.

He looked at the others to see if they'd gotten the clue and was answered by grim faces and grave nods. They had. They would have only seconds before this shuttle's hobbled brain realized they knew and disabled them. Soob took his slate and scratched on it: "gas hoods."

The shipsuits had hoods with clear visors packed in their collars. They would provide protection against a knockout gas, if that was what was intended for them. A quick look at the environmental systems display panel showed fan level at max—something was being blown into the command deck as fast as the shuttle's systems could send it. Without delay, Jacques released his hood, pulled it over his head, and sealed it at the neck. Soob had his on, too, as did Collette.

Doc and Helen weren't quite in time, and slumped, unconscious, in their seats as the spacecraft settled to the ground.

Collette was at the command deck hatch in a flash, and cranked it shut manually, while Jacques and Soob finished getting the hoods over Helen and Doc.

"This is *Resolution* Shuttle *Intrepid*. You are under arrest by order of the President of Providence. It is a crime to resist this order. It is also impossible as you will eventually run out of air. You must submit to the authority of Captain Suretta, who will bring you into Providence."

* * * *

Chapter 18

On Being Born Again

"Not in your cybernetic life," Jacques said, and jumped over to the primary memory panel. It was locked, but he now had a laser tool and quickly cut through its thin composite material. The sound of a torch working on the much more solid material of the command deck hatch reached him. He only had a few seconds.

He fumbled with the panel.

"I think we have about twenty seconds," Collette said, as she motioned the others into defensive positions. They would block the door as long as they could. Helen had found a roll of space tape and taped over the cut as the

robot cut it. It would take the torch only seconds to cut through that “repair,” but those would be precious seconds.

Jacques turned back to his work and focused. Like the *Fortitude*, the *Intrepid* had been hacked with a single ersatz memory module. His fingers were like thumbs; the damn thing was stuck in, not budging. His fingers slipped off it, time and time again.

Screwdriver! He fumbled to find it in his tool kit. The torch stopped, followed by loud bangs.

“Jacques,” Collette yelled.

He had the screwdriver and pried at the module, ignoring thumps and curses behind him.

Then it broke free, and Jacques yanked it out.

Silence fell on the command deck. He turned to find his comrades covered with three or four maintenance robots each, stuck to them like crabs, covering their faces and hands. He felt something on his own back; he hadn't noticed it before. It had been that close.

“*Intrepid*, this is Jacques Song...” he said, beginning the same routine he'd used on the *Fortitude*. When he finished, the maintenance robots meekly abandoned their positions and skittered back to their stations. He found the backup modules, rebooted the AI, and summoned up a view of the shuttle's exterior.

Leo was standing near the entrance hatch. He obviously knew something was amiss; he had a gun out and was looking at his wrist comp and talking.

Collette stared at him. “Three shuttles. Of course. We knew that. We should have been asking ourselves where the others were.”

“Just blast off right now and we solve a whole bunch of problems,” Helen said.

“Uh-uh,” Collette said. “Bring him in. I've got a lot of questions.”

"I think what Helen means," Doc said, "is that the whole question of governance, and thus the authority of anyone to imprison or try anyone else is very murky in these circumstances. The legal tradition is for settlements to elect their leadership. We, in essence, lost that election."

"This is not a colony or an intentional settlement." Collette responded. "However removed, we are still part of a Solar System expedition, under the authority of the government that sent it."

Jacques watched Leo outside, pacing with increasing restiveness. Might he try to shoot his way in? "People, the alternative to us taking charge appears to be to allow mass murderers to run things. For now, Mr. Suretta waits outside with a gun. As Helen points out, to simply blast off with him in his present position would solve a lot of things. I'm not sure the shuttle AI will do that, however. Does anyone have any ideas about how to disable Mr. Suretta without doing him great bodily harm?"

"Do we still control *Fortitude*?" Helen asked. "Could its robots do something?"

"In an hour or so," Doc said. "It's on one of the other Cube World faces now."

Soob wrote furiously.

"We have one robot outside now," Helen read, with a puzzled look.

Doc laughed. "Of course!"

Half an hour later, they watched Leo Suretta collapse from a dart fired by a tranq gun held by the miniature kangasaur that had been unloading the nutrient shipments.

Leo couldn't see both sides of the shuttle at once, and they'd gotten the tranq gun out a maintenance door just big enough for Helen's arm, after they'd removed the intervening equipment.

With Lt. Collette's prisoner secured in one of the *Intrepid*'s berths, they lifted off for New Landing, or "Providence" as Gabe had apparently renamed it. For good measure they contacted the *Fortitude* and had it join them. The *Resolution*'s shuttles set down on the beach on the north side of New Landing.

The place had grown, with several huts on stilts near the cave mouth, fish and laundry drying on lines, and a faint whiff of untreated sewage.

One would expect that two spaceships landing at this settlement of some stranded astronauts would have attracted some attention, Jacques thought. And it did. Everyone was open-mouthed except for Gabe. He sat down and cradled his head in his hands. Then he focused on Jacques.

"Where's Leo?" he asked, simply.

"In custody," Collette answered. "What was your role in all this?" she asked with a wave toward the shuttles.

"Leo woke me up before we hit this planet's atmosphere. He told me to be on the *Fortitude*," Gabe said, "and said the ship would notify the others. Look, this was a chance to go back to Eden. To get everything right. To live the way..."

"What others?" Collette demanded.

"I'm sorry about not telling you about the shuttles, but if y'all knew, you wouldn't have formed the community. You all would just try and build a starship to go back to something that was over and done with thousands of years ago. There's a way people were meant to be, and that's not part of it any more than what those New Reformationists were doing."

"What others?" Collette repeated.

"Leo, Evgenie, and I were on one. There's a group over on the face east of here from the *Intrepid*. They're the control group; they know about the shuttles. The third shuttle crashed."

"Control group? You were running an experiment?" Doc sounded incredulous.

"I had some ideas about how to ease the New Reformationists back into the fold. I sort of adapted them to the situation."

"Which you helped engineer," Collette stated.

Gabe shook his head. "No, no. We were already here when Leo woke me up. We discussed how to handle things. He'd just found out and had some good ideas about how to handle this." He looked around at a sea of stony faces. "At least I thought so."

"Then it was Leo who disabled the homing lasers," Collette said, looking at her copcom.

She could probably tell if he believed what he was saying, Jacques thought.

Gabe looked absolutely miserable. "I don't know that for a fact."

"Let's say I believe you. The circumstantial evidence is overwhelming."

"Leo sabotaged the deceleration mechanism at 36 Ophiuchi?" Maria Lopes questioned. "He wouldn't do that! He's a good man! Where is he?"

No one said anything for several minutes. This was going to be very difficult, Jacques knew.

"He's in custody," Collette said. Slowly and carefully, she took Maria through everything Leo had done, from the initial sabotage and his efforts to see that only a select group of reliable people were on the shuttles to keeping their existence from the rest of the survivors at the price of letting Jacques' group go off to what they thought would be certain death.

"How are you going to have a trial?" Gabe asked. "What are you going to do, hang him?"

"Maybe we'll think of something," Doc offered. "What about Ascendant's murder?"

Gabe wasn't looking at him. He was looking up at the path down from the Rim and pointing with a shaking finger at the end of a shaking arm. A lone woman in what looked to be a shipsuit was walking down the path from the rim.

"Do you believe in ghosts?" Gabe asked, pointing to a woman walking down the path. Then he laughed hysterically. "Cause if you do, you all can ask *her*."

The woman descending the path looked exactly like Ascendant Chryse.

* * * *

Chapter 19

Beyond Crime and Justice

"There's nothing to fear," she said as she reached the group and touched a shuddering Gabe. "I'm flesh and blood, nothing supernatural."

"Whoever built this world ... rebuilt you?" Doc asked.

"I'm not a robot, Doc. The caretaker's nanites recorded my brain and my DNA. Its replicators are somewhat more advanced than ours." She grinned. "I'm missing some memories, some scars, and I'll need to work on a tan."

"But you are a mind reader, now, it seems," he said, smiling slightly.

"I made a good guess," she answered. "Though the latter is possible, if we want to do it."

We. Jacques shuddered. Whatever ran this place apparently could replicate whatever it chose, which did not surprise him too greatly, and had the willingness to use it in this fashion, which did.

"Are you really Ascendant Chryse?" he asked.

"I certainly feel like me, but thanks for saving the diary, Jacques. I went to sleep in my CSU and woke up at Rim Camp. But, and this will be difficult

to explain, I'm much more than me."

"More? Who or what are you ... now?" Doc asked.

"On a time scale of milliseconds, my awareness extends to this entire world; on a time scale of hours, this entire planetary system; on a time scale of decades, all the stars human beings have settled; on a time scale of millennia, a part of an arm of the Milky Way and the wisdom of ten thousand races; and on a time scale of hundreds of millennia, the collective culture of our galaxy.

"But there's more. I compass a heritage of races including some now beyond the horizon of space and time—though, and I can only explain this in metaphor, the far horizon is quite misty."

"Intelligent life may be the Universe's way of becoming conscious," Collette said in hushed tones. "Or something like that. I can't remember who said that—hundreds of years ago."

"Carl Sagan, on Earth. Also by millions of other beings on millions of other planets," Ascendant said.

Soob pulled his slate out of his bag, scratched on it, and showed the others what he wrote: *Did you meet God?* He handed it to Ascendant.

Ascendant smiled and kissed Soob on the forehead. "Feel better?"

"Very much," Soob said. "Oh, my..."

"God," she said. "The word 'meet' doesn't quite do justice to my present circumstance. Tell me, does it make a great difference to you that I did this with nanocells rather than some supernatural force?"

Soob took a long time to respond. "In a philosophical sense, a very profound difference; in a practical sense ... perhaps none at all."

Gabriel Eddie sat on a rock and covered his face with his hands. Evgenie, Arroya, Maria, and Dominic gathered around him. Edith stood, staring at Ascendant.

"There's a net here?" Doc asked. "I don't sense anything."

"Different frequencies and protocols," Ascendant said. "We'll fix that later."

"Are you an individual or part of a collective mind?" Helen asked.

"The question itself assumes categories that don't really apply," Ascendant answered. "Our language requires me to use singular or plural pronouns, thus misleading you greatly. The sort of isolation that you experience, and I did, before my ... change ... is a very primitive characteristic by galactic standards, a stage that many races went through and most passed beyond."

"When we left the Solar System," Collette said, "most philosophers ascribed the lack of contact with other civilizations to a very strong quarantine, an ethic much like that of our own environmentalists that forbids interference with nature."

Ascendant smiled. "But that can't go on forever, can it?"

Jacques nodded. "Eventually, we would start impacting other civilizations. We've probably screwed things up here, ecologically, haven't we? As I'm sure you know, that was not the choice of any of the individuals here."

"You have killed sentient beings to keep your individual selves alive. In most of the galaxy, that would be regarded as a very primitive characteristic in a spacefaring race. As people, we are still driven by emotions, needs to dominate, reproduce, preserve ourselves. Most of the Universe has moved beyond that."

"So, the caretaker of this world does nothing? Just watches us suffer?"

"Think of all the life forms that feel, hurt, need, and suffer and all the gradations of awareness. Suffering can't all be banished, but it can have meaning from what comes later. We were left—allowed—to solve our problems by ourselves."

"What changed? Why were you resurrected? Why contact us now?"

Ascendant giggled. "I'm still human enough to enjoy this. Dear, dear Jacques. We, the human race, solved our problems. We're out of the cradle and off the rug, so to speak. Just taking baby steps, mind you, but it's time for humanity to learn the rules."

"Humanity?" Doc asked. "Does your, uh, expanded awareness have some news from the Solar System?"

She nodded. "There's a lot to talk about. Have you seen the new star in the sky?"

"Near Antares," Jacques said. "We have to catch it just before Antares rise, or the glare hides it."

"It's a starship decelerating. The Solar System has found you. They'll be here in a few months."

* * * *

It was a clear, still, dry evening and exceptionally cool for their altitude. The women of Providence, perhaps sensing that their way of life was to change unalterably again, made the best of things by putting on a feast around the campfire. The shuttles replicated some wine and beer, the first spirits anyone had tasted for six subjective months, or a thousand years of real time.

So fortified, with Ascendant's help, they caught up, at least to circa 2800 ce. Earth still maintained a stable constitutional monarchy, but that was for tradition and show; AIs did everything and the only person with a real job was the Empress. The ancient effort to rescue the 36 Ophiuchi colony had been successful, if one could call the thousands of deaths that involved a success. It was the last such effort ever attempted.

Human-derived colonies still, occasionally, did some horrendous things, but the Universe had better ways of dealing with that. Nanites invaded bodies and changed minds.

Humans had made a black hole, and now had hundreds of them powering space colonies, performing physics experiments, and generally being useful. The initial effort had drawn the attention of passing spacefarers of an ancient but conservative-by-choice branch of a civilization of flying aliens. Not long after that, a galactic library node had been discovered in Neptune's moon, Proteus. So, well before the *Resolution* hit Cube World, humanity had found its way into the galactic community.

Ascendant concluded by saying that she might very well be a common example of the human-descended beings they would encounter in the Galaxy today, but the variety was wide.

Gabe said, "I knew we'd be a group of Rip van Winkles, but *this ... this* will take a whole lot of digesting."

Ascendant laughed, as did a number of others, at first timidly, then heartily. What Ascendant was telling them was hard to grasp, but Gabe was clearly finding it harder than most. Jacques added, "And we are still six hundred years behind the times."

"Or ahead of them, depending on which way the information is flowing," Helen noted. "I imagine this story will still make a splash on Earth!"

"Are we welcome here?" Arroya Montez asked. "Do we have to go back? I have a very simple, stable life here, with Evgenie. My knowledge is all out of date, and I would have no place on Earth now."

Ascendant smiled at her. Jacques thought there might have been something like recognition in her expression. But she gave no hint of it as she answered Montez's question.

"This world is an experiment in evolution. Six identical environments and with identical seed stock, constructed by beings not too unlike your kangasaur about half a billion years ago, a race not entirely given to theory and abstractions.

"What, they wondered, if one reran evolution for real; would the Universe produce anything like them again? So they put it to the real test. It's been

running about two hundred fifty million years. The cube shape is a bit of whimsy, or art. But it's also functional; the biospheres remain isolated and the long slide of basalt down the cube face edges drives the tectonics that recycle this world's carbon."

"Our landing must have upset things," Doc said.

"Like the KT impact on Earth?" Soob remarked. "Contingencies, like us, are what drive evolutionary change."

Ascendant laughed. "Yes, all grist for the mill. The caretaker takes it in stride."

"We aren't going to get kicked off?" Dominic asked. "We can stay here?"

"It is a bit unusual. In the quarter billion years Cube World has existed, only 1,728 other intelligent races have stumbled upon it before their incorporation into galactic society. Twenty-three hundred years is the longest any of them have stayed. The resurfacing time is about fifty-seven thousand years. Now, the beings Jacques calls dinotowers have long memories, but there is no other trace of these visitations in any of the biospheres. You're welcome to stay a while as long as you control your numbers."

Gabe shook his head. "Do we want to? My God says I shall have no other gods before 'im. I'm not sure where alien planet-ruling machines fits into that."

"You'd probably find Earthmind quite a shock, then," Ascendant said. "It's a virtual universe for people who tire of biology."

"Oh, Lord," Gabe sighed. "Were we wrong? Or ... were we right?"

Ascendant smiled. "Here, you'll be left alone as much as you wish, while you figure that out."

"Maybe that's good for now, Gabe," Maria said.

"We still have some formalities of justice to consider," Collette declared.

"Judge not," Gabe said softly, "lest ye be judged."

Everyone was silent.

"What does justice mean now?" Soob finally asked. "What purpose is there in punishment? I suppose one wants to do something to ensure that a perpetrator doesn't act obnoxiously in the future. Even if murder, or should I say attempted murder, is futile here, I would think it would still be quite an inconvenience. The whole point of this galactic ethical structure seems to be that beings, as collective races, I suppose, have a right to seek their own destiny."

Ascendant laughed. "Not badly put. While I am very comfortable with who I am now, it is true that I would not have chosen this experience for myself. But as for what you do about Leo, we human beings can be human beings as long as we don't ... greatly inconvenience ... others."

"Or until we decide to be something else?" Helen asked.

Ascendant nodded. "It seems fairly certain that you will, eventually. But there's no hurry and there will certainly be no coercion."

"I'd always feel someone is watching over my shoulder," Helen said.

"A new feeling for an atheist, I'd guess," Gabe said, reviving a bit.

"Did Leo kill you, Ascendant?" Doc asked.

She smiled with a shake of her head. "Not for lack of trying. Leo Suretta, or Leo Syrtis, as he was named at birth on Mars, was the New Reformation's agent on the *Resolution*. It was supposed to be a martyrdom mission, for him, murder for the rest of us—or perhaps an act of war. But I was up and managed to restore the AI and wake the command team in time to devise and implement the contingency plan. We found this place, so Leo saw an opportunity to create another authoritarian culture." Ascendant sighed. "He arranged for people he thought would make the kind of society he wanted to be on the shuttles."

"The CSUs were safer," she concluded. "There was no guarantee the shuttles would survive the hundred-kilometer-per-second crash into Cube World's atmosphere. One of them, the *Purpose*, did not. Leo thought the gamble was worth it. A megalomaniac's collateral damage."

Maria sobbed.

"But," Collette said, diverting attention from her, "Leo's sabotage didn't kill Ascendant, and neither did Gabe—they hadn't arrived on our island when that happened. Her CSU log wasn't wiped until later, right, Gabe?"

Gabe nodded. "Leo didn't want problems about how we got here confusin' people about what to do now that we were here."

"Ascendant, do you know who turned off your CSU power, while you slept?"

"Actually, I don't. We are all scanned, but only every few nights. The caretaker didn't happen to be watching."

"No matter. I think I know. There were two shuttles," Collette said. "Leo and Gabe were on one, and on the other..."

Arroya Montez quietly tried to slip away from the fire, thus assuring that all eyes fell on her. Evgenie got up to go after her.

"Arroya," Ascendant called after her "I'm not dead, so there is no murder, and I assure you I am no danger to your happiness with Evgenie. Be at peace. I forgive you."

Gabe groaned, "Now come on, you're tryin' to sound like..."

Their eyes locked and Gabe's face lost its color. Very slowly, he asked, "That whatch-youcallit, library node, they found in the Solar System. It hasn't been there three thousand years or so, has it?"

"More like three million, Gabe." Ascendant wasn't smiling.

Gabe fell silent. Jacques imagined an orchestra playing *Also Sprach Zarathustra*.

"How far back does the oldest part of you go?" Doc asked. "When did the Universe become conscious?"

"The eldest we know of came from a planet about a star much like this one in a dwarf galaxy now beyond the universal expansion event horizon. They were much closer nine billion years ago and spread their—I think 'culture' would be the best word—far and wide. Their ethics became the model for everyone since, though great minds have thought alike in this area.

"Speaking of ethics, Jacques, Leo should be here."

Jacques nodded, contacted the *Intrepid* and directed that its robots bring Leo to the gathering, unrestrained. No one had anything to fear from him, not ever again.

When he arrived, he looked at Gabe, Jacques, and then, tight-lipped, at Ascendant.

"I'm Ascendant Chryse," she said.

"The shuttle told me." Leo's voice was tense, his tone defiant.

"We know everything," Collette said.

"You may forgive yourself, in time," Doc said.

Leo snorted. "Forgive myself? I'm proud of what I tried, damn it. I tried to save mankind from this damned, banal, inhuman fate. I tried at 36 Ophiuchi and I tried here. You aren't human, Chryse. You're not more than human, you're less. You're an abomination. An alien puppet."

Leo pulled out a gun; he apparently had a stash of them somewhere, Jacques realized.

Doc laughed. As the others realized the futility of Leo's weapon they began to laugh as well. Except Ascendant, who looked very sad.

"Yeah, real funny." Leo said. "Well, I'm betting you aliens are just too damned civilized for eternal torture. I quit."

He turned the gun on himself. Nobody made a move or said a thing to stop him. He managed to fire five times before collapsing.

Everyone looked at Ascendant. She had a tear in her eye. "I could have done something, but I am informed that wisdom lies in respecting his wishes. He won't be revived; that *would* be torture."

* * * *

Chapter 20

As in the Beginning

Before they left for the Solar System, Jacques and Collette visited Face One a last time. With power-assisted wings, they covered the distance in three days, reliving adventures and overnighting at Rim Camp and River Camp, before ending up at Ascendant Chryse's lodge near Eagle's Nest. Soob, Helen, Doc, and their children were there. The oldest, Athena, was now approaching puberty, and as clever as her mother.

"Are you sure?" Jacques asked Ascendant.

Ascendant put her arms around him, acknowledging that in some alternative existence, and perhaps some future one, they were soulmates.

"This is where I belong now," she said. "We need to develop a different view perspective of time; by Galactic standards, I am really not so far away. Besides, I'm pregnant!"

Soob was grinning ear from ear. "I'm going to enjoy exploring the other cube faces and renewing acquaintances with other resurrectees."

"And someone needs to keep the fear of god in Gabe," Helen added.

Doc chuckled. "Gabe enjoys leading, and the people with him enjoy being led. Their first generation is just coming of age. I'll enjoy watching them

rebel."

"The galactic data base here is larger than the library node in the Solar System," Helen said, "and with my family, I'm really happy. So come back in a couple of millennia!"

Then they said their farewells, Collette took his hand, perhaps a bit firmly, and led him back to the *Fortitude*. Hours later, with them aboard, *Resolution III* picked up the beam to Earth.

Within a day, Cube World's star shrank noticeably. When it dimmed to about the same apparent luminosity as Antares, they made love once more, then entered their CSUs. Years later, they revived briefly to gape at the glowing red mist of the supergiant star as its gravity bent them toward Earth. But it too dwindled, and Jacques made one last check of his enhanced emergency kit and permitted the CSU's transparent lid to settle down over him for the six-hundred-year journey. For him, the thirty-third century had ended, and the thirty-ninth would soon begin.

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Reader's Department: **THE REFERENCE LIBRARY** by Don Sakers

It's the time of year for universal peace, goodwill, and gathering together with family and friends. This time around, I have something naughty, something nice, and some helpful gift suggestions. First, the naughty:

* * * *

Death's Head: Day of the Damned

David Gunn

Del Rey, 346 pages, \$26.00 (hardcover)

ISBN: 978-0-345-48404-8

Genre: Military SF

Series: Death's Head 3

* * * *

In the mainstream suspense/thriller genre, there is a very popular subset of books written by former military men (and, sometimes, women): rough-talking, hard-living men who sling authentic lingo about weapons and warfare; men who, given the slightest provocation, are two-fisted death. Some of these authors use pseudonyms; one gets the idea that hostile foreign mercenaries are close on their trail. In extreme cases, author bios hint that the writer spends most of his time on covert missions in the Middle East, Central Asia, or the jungles of Latin America ... presumably dashing off books by flickering torchlight during lulls in the fighting.

All of this is meant in the spirit of fun; after all, who wants to read a military adventure written by an accountant from Connecticut?

Now SF has its own mysterious military man: David Gunn. According to his bio, Mr. Gunn (we all believe that's his real name, right?) "has

undertaken assignments in Central America, the Middle East, and Russia (among numerous other places). Coming from a service family, he is happiest when on the move and tends not to stay in one town or city for very long."

Death's Head: Day of the Damned continues the story of Sven Tveskoeg, a lieutenant in the Death's Head, the elite fighting force of the Octovian Empire sometime in the distant future. Sven is a genetically engineered super-soldier who lives to kill—and he's very good at it. Humans, alien monsters, game animals, the odd lizard or two: Sven kills them all with a dizzying assortment of weapons, all lovingly described. He has a prosthetic arm which sprouts knives whenever necessary; he has guns (including his favorite SIG-37, an AI-enhanced heavy pistol that throws an assortment of bullets and wisecracks with equal ease); he even has a handy portable planet-buster bomb just in case it might come in handy (and son of a gun, by the end of the book it *does*.)

Sven has various friends besides his gun: most notable is Aptitude, a teenage girl who is only slightly less capable and bloodthirsty than Sven himself. Together, they fight their way through a civil war that has split the Octovian Empire and the Death's Head itself. He faces conflicting orders, betrayal, and enough enemies to make the pages seem to drip with blood.

The style is terse and harried, with little subtlety. Sven and his fellow soldiers communicate in short, matter-of-fact utterances that are a step above grunts. In "authentic" military fashion, four-letter words proliferate, violence is everywhere, and all of the characters seem to harbor deep hostilities toward one another.

To be sure, there are some interesting touches hiding in the background. The Emperor, OctoV, is a part-human, part-machine construct that eternally manifests as a 14-year-old boy. The Empire's chief antagonists are the United Free (or U/Free in military parlance), a cultured society with the power to move planets and extinguish stars. But in the main, the background and plot are excuses to get Sven moving across the landscape, slaying everything he comes across.

By now you may have recognized what *Death's Head: Day of the Damned* is all about: it is essentially the printed and bound equivalent of those video games in which one wanders around the neighborhood shooting at everything that moves, splashing blood all over the screen and racking up points. And for what it is, the book does a good job.

If that sort of thing appeals to you, you'll like this one.

* * * *

Webdancers

Brian Herbert

Five Star, 522 pages, \$25.95 (hardcover)

ISBN: 978-1-59414-218-5

Genres: Bigger Than Worlds, Space Opera

Series: Timeweb Chronicles 3

* * * *

Now for something nice.

It's impossible to mention Brian Herbert without also mentioning that his father was Frank Herbert, bestselling author of the Dune series. Since Frank's death, Brian has continued the series in a string of bestseller collaborations with Kevin J. Anderson.

What is so often forgotten is that Brian Herbert had his own independent sf writing career before taking up the reins of the Dune franchise. His solo work included genuinely funny books like *Sydney's Comet*, *The Garbage Chronicles*, and the exquisite *Sudanna*, *Sudanna* (in which chuckle builds on chuckle inexorably, until without quite noticing it you're laughing so much you can hardly breathe).

Recently, in between Dune books, Brian Herbert has been crafting a space opera as big as the galaxy; like the best space operas, this one moves from simple sf into the realm of brand new mythology.

The Timeweb Chronicles concern the Timeweb, a multidimensional structure that fills the galaxy, connecting stars and planets with communications and transport. Sapient podships travel along the Timeweb at faster-than-light speed, bringing together diverse races and cultures.

The hero of this epic is Noah Watanabe, an ecologist who once specialized in repairing damaged planets. By this third volume, Noah has turned his attention to the greatest ecological crisis of all: the disintegration and death of the Timeweb itself.

As the Web decays, the Human Merchant Prince Alliance joins with their erstwhile enemies, the shape-shifting Mutati Kingdom. Meanwhile, Noah finds his paranormal abilities boosted by a connection to an ultimate power, and begins evolving into something beyond human. Whether this power is for good or evil, he does not know.

I'm not going to tell you that The Timeweb Chronicles are easy reading. Each volume weighs in at over 500 pages of prose that can sometimes be as dense as the worst excesses of his father. But it's rewarding work: the universe of the Timeweb is spectacularly wonder-filled, and the story is mythic.

Fair warning, though: this is one of those trilogies that's really one long super-novel; if you start with this third volume, you're really cheating yourself. Book One is *Timeweb*; Book Two is *The Web and the Stars*.

If you like far-future space operas teeming with interesting aliens and larger-than-life characters, give this one a try.

* * * *

As hardcore sf readers, it is always incumbent upon us to try to share the wealth (or, if you'd rather, spread the infection). Gift-giving season provides a perfect opportunity for proselytizing ... er ... *sharing*. Your targets might

be friends, coworkers, children (your own or someone else's), or random strangers. The right story, book, or author may just turn a person on to science fiction. This world needs more sf and more sf readers. So let's get started.

It should go without saying that a subscription to *Analog* makes an excellent gift for anyone who fancies science fiction ... but I'm saying it anyway. Subscription information is readily available in the pages of this very magazine, and the recipient will thank you all year.

In the past few months I've reviewed a number of fine novels and anthologies that would make great gifts for adult sf readers, and I'm not going to go back over that ground. Instead, I want to give you some ideas for the younger folks among your circle, particularly those who might not regularly read sf.

* * * *

Gantz (multiple volumes)

Hiroya Oku

Dark Horse Manga, \$12.95

ISBN: varies

Genre: Manga

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The anime/manga genre is big with teens and young adults—and more than a bit of an enigma to many sf-reading older adults. It's that Japanese stuff, largely fantasy, that all the kids seem so excited about these days. Nowadays there are lots of swords and magic and dragons and demons ... but it all started as good old science fiction: the lovable robot that we English-speakers learned to call Astro Boy.

If the entire anime/manga scene is unfamiliar to you, a little terminology may help. “Anime” is video: movies and television. “Manga” are printed

volumes that combine pictures and words (like comics). Manga are generally printed in thick pulp-like paperbacks, and most of them are read back-to-front (in the Japanese style). Usually, a story in manga form consists of ten or more individual volumes. A particular story may be told in anime form, as manga, or both.

If you know a young adult or mature teen who fancies manga, you may want to give them something with more science fiction content. *Gantz* is a good choice.

The story is fairly simple. Some recently dead folks awaken in a secluded room dominated by a mysterious talking black sphere, which calls itself *Gantz*. These folks have been cloned and resurrected in order to serve as agents for *Gantz*: it arms them with special suits and weapons, then sends them on missions to confront hostile aliens that are invading the world.

Or maybe it's all a virtual-reality game, run by an unknown game master for some obscure purpose.

Gantz is not for kids: there's a fair amount of violence, foul language, and some sexual content. But the characters are compelling and the story psychologically gripping. The art is superbly atmospheric. Give this to your favorite young anime fan, and you'll quickly become the coolest "old person" they know.

If you aren't already.

* * * *

Little Brother

Cory Doctorow

Tor, 382 pages, \$17.95 (hardcover)

ISBN: 978-0-7653-1985-2

Genres: Cyberpunk, Teen SF

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It's been said that most books for teenagers are based on the literary form called Rite of Passage, a ritual in which a young person learns to assert his or her independence while becoming part of the larger society. Combine the Rite of Passage with science fiction, and the result can be very powerful. That's certainly true of many of the great classic "juveniles" by the likes of Andre Norton and Robert A. Heinlein. *Little Brother* is the first of a pair of recent teen sf novels that would make great gifts for the teenagers in your life.

Marcus Yallow is a high school senior in San Francisco, and he's a whiz at computers and the Internet. Moreover, he knows it; he is smarter than any of the adults around him, and he's not shy at expressing his contempt for them.

Now before you go disliking Marcus, you have to understand that this sort of thing is part and parcel with books for teens. If one is going to have teenage protagonists getting into various troubles and getting themselves out, then one has to de-emphasize the adult characters. It is an unspoken assumption of children's and teen fiction that most adults are stupid, ineffectual, or both. (Just look at what idiots the adults are in the *Harry Potter* books.) Adult villains can be a little more canny than friendly adults, but ultimately the kid has to outsmart them in the end.

It's no use protesting—the books aren't written for us adults, anyway. And the kids who read them don't notice.

Back to Marcus. He and his friends, deep into a live-action role-playing game, ditch school and go in search of clues. But they are in the wrong place at the wrong time when a major terrorist attack hits San Francisco, killing thousands.

Suddenly Marcus and his friends are detained by the Department of Homeland Security. With their encrypted computer files, mad hacking skills, and ability to evade school surveillance technology, they look an awful lot like terrorists.

Imprisoned and psychologically tortured, Marcus gives up his passwords and files, and after a few days he's released. One of his other friends is also set free; the third remains missing and (presumably) still in custody. But that's only the beginning of the story.

Over the next weeks, Homeland Security turns San Francisco into a police state bristling with security measures. And Marcus realizes he has a mission in life: to use his knowledge and his networks (both computer and personal) to bring down Homeland Security.

Although a little preachy in spots, the story is exciting and Marcus winds up being a fairly sympathetic character (even for old people like me). The story of one boy's opposition of authority is bound to please most teens.

* * * *

The Hunger Games

Suzanne Collins

Scholastic Press, 374 pages, \$17.99

ISBN: 978-0-439-02348-1

Genres: Post-Apocalyptic, Teen SF

Series: Hunger Games 1

* * * *

Katniss Everdeen, 17, lives a hard life in the Seam, an impoverished village in District 12, one of the poorest of the twelve Districts that make up the nation of Panem. Ever since her father died in a mining accident, Katniss has been the primary breadwinner for her ineffectual mother and her frail younger sister. Along with her male friend Gale, Katniss spends most of her time hunting and gathering in the forbidden forest, then trading with other villagers for the necessities of life. It's subsistence living at best.

Once a year, by law, comes the Reaping. All children between twelve and eighteen are entered in a lottery, and each District draws two Tributes: one boy and one girl. The Tributes are sent to the Capitol to compete in the Hunger Games: a reality show gone mad, a no-holds-barred fight to the death where only one child survives.

To Katniss's horror, this year's winner is her little sister. Without thinking, Katniss steps forward to take her sister's place in the Games.

The rest of the book tells the story of Katniss's participation in the Games, her struggle to survive and overcome the other twenty-three contestants, and her ultimate fate.

This gripping story is also sophisticated science fiction, as rewarding to adults as to the teens who are the main audience. Besides the survival plot, there is a larger political plot going on here. The Capitol uses the Games as but one weapon for subjugating the Districts; Katniss is as much freedom fighter as she is reality show contestant.

Along the way, Katniss learns quite a bit about her fellow humans ... and more than a bit about herself.

The Hunger Games, while a complete story, is Book One of a series. There's certainly more to be told of Katniss and the richly detailed world she inhabits. I look forward to Book Two.

* * * *

There you have it: something naughty, something nice, and some gift ideas. May your winter holidays of choice be rewarding, and I'll see you back here next year.

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Don Sakers is the author of *A Rose From Old Terra* and *Dance for the Ivory Madonna*. For more information, visit www.scatteredworlds.com.

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Reader's Department: **BRASS TACKS**

Dear Stan,

Thank you for your piece, “Signs of Respect,” in the June issue. You touch on a subject that has interested me for a long, long time.

When I was in primary school, more years ago than I care to remember, I attended a small school (twenty kids) in the middle of a feudal estate in South-western England. From time to time, as I made my way along footpaths in the forest, to and from school, a member of the land-owning gentry would pass me, coming or going. I always did what we children were told to do, and tugged a forelock as the individual passed me. Later, when I noted that grown-ups did not follow the forelock rule, I concluded that it was designed to show not respect, but subservience. I did not like it, but I still obeyed the “phantom tyrant.”

Later still, when I knew a bit of history, I concluded that the Magna Carta (1215) was all about forelocks. The barons of that time hated having to show, by that or some other similar motion, their subservience to the king, so they rebelled and reduced the king to a lower level of dominance.

I used to muse on the fact that it took over seven hundred years for the principle to go from general to minimal use.

King and country needed me in the Army in 1944. I learned about saluting, and concluded that it was nothing but the forelock thing all over again, a reminder of my own subservient status. I never did think of it as a mark of respect.

At that time, I began thinking about culture and the organization of society; that is, about the *phantom tyrants*. I don't know how long it took me to arrive at this conclusion, but I concluded that *culture* was what people did without thinking about it, and its development was helpful to persons in authority—it made the behavior of subservient persons predictable.

Probably a good deal later, I thought about silverback gorillas, about elephant matriarchs, and alpha male wolves. Humans, I thought, probably also need dominant leaders to survive. Likely, that has gone on for so many generations that evolution has implanted it in our genes.

Another long time ago, when I was still quite young, I read Arnold Toynbee's model of human affairs, presented in his *Study of History*. Toynbee, you may recall, reckoned that societies facing serious challenges to their survival develop *creative* minorities who resolve their problems. Later, with the problems resolved, societies succumb to the authority of *dominant* minorities, non-problem-solvers with a vested interest in maintaining status quo. This works well enough, until a new set of challenges develops, whereupon the dominants, unable to cope, go to war, becoming more tyrannical along the way. War destroys the society, whether it be tribe, nation, empire, or civilization, but creatives re-emerge, and we start all over again.

Well, that is a gross over-simplification of a twelve-volume work, but it is, perhaps, enough to be relevant. With Toynbee in mind, I let my thoughts regress to hunter-gatherer times. Creatives, over thousand of generations, must have observed the migrations of game, the succulence and timing of edible fruit and plants, and must have established myths—cultures—that enabled dominants to take over and exercise their tyranny. Evolution probably did the rest. Once again I concluded that our human actions, such as males taking off their hats indoors, are most likely genetically based, enforcing conformity on the lower classes, and creating obedience to the dominants. For as long as humans existed, these were life and death matters. Our subjection to phantom tyrants must go very deep within all of us.

Dominants, of course, indulge in ever-harsher measures to enforce their tyranny. We, in our time (and place) enjoy an exceptional measure of freedom. But it does seem to me that after the creative decades following WW II, the dominants, here and elsewhere, have been gaining. Recently, inspired by the war in Iraq, I wrote a poem—actually a ghazal—in which a desert hermit reminds a passing camel-borne aristocrat of the two problems that humanity must always confront. The first is that of those in authority—

how to control the People. The second is that of the People—how to control those in authority. Unfortunately, modern IT and communications technology vastly increase the power of those in authority. That is something to think about, every time you find yourself taking off your hat, as you go indoors.

Thanks again. Best wishes, and apologies for running on and on.

Brian C. Coad.

* * * *

Dear Doctor Schmidt,

Your editorial about the all-too-common modern fantasy of achieving absolute safety was one of those, which, in my more romantic moments, I dream might someday not need saying at all.

I half-expected you to bring up an obvious counter-example to this kind of unthinking hysteria; since you didn't, allow me to do so.

I wonder (in both senses of the term) why it is that we don't also see editorials and political campaigns aimed at real-life dangers that in fact take many, many more human lives every year than have Canada geese over the entire history of powered flight. If the *Post* were really concerned about the safety of its readers, surely it will publish many editorials demanding that cars be limited to speeds of no more than 20 kilometers per hour, if not that the private automobile be banned altogether.

On an entirely unrelated note, if Don Sakers' first column is anything to go by (and why wouldn't it be?), you have found an excellent replacement for Tom Easton as your resident book reviewer.

Sincerely,

Geoffrey Dow

* * * *

Dear Dr. Schmidt:

Your editorial about the *NY Post* screaming for blood after geese disabled the USAIR jet, forcing its heroically successful, controlled crash landing in the Hudson River, grabbed me hard in two respects. First, thank you for once again pointing out the folly of tendering perfect safety as public policy. In addition to the impossibility of the goal and wastefulness of its pursuit, I believe you have pointed out elsewhere the danger of diverting public emphasis from the kind of self-reliance on which the possibility of persistence as a free people depends. Such ad hoc rationales as the preciousness of every single human life over ALL alternatives are fallbacks in arguments for many popular causes, from the right to bear arms to music in the public schools and the right to go to college. We need a better rationale. May we find one soon. Second, I am just exasperated enough with the ubiquitous public nuisance afforded by Canada geese where I live (northern Ohio), yet mindful of the fact that not many decades ago we had NONE, that I would love to see a national goose harvesting program go into effect as soon and enthusiastically as possible. "Stamp out hunger: eat a goose today!" If even one child can be saved from malnutrition...

Joseph E. Quittner

Cleveland Heights, OH

* * * *

Stan,

Your September editorial ("Where Credit is Due") really struck home with me, especially your schools and your teachers. I was born and raised in the little (1,400 people then) historic town (you can Google it for its history) of New Harmony, Indiana. The school was just one building: eight rooms for the 1st through 8th grades, and in the high school area: a language room (English and Latin; I took four years of Latin!), a math room (including advanced algebra and solid geometry), a history and social studies room, and a large assembly room where we each had a desk assigned.

As I have realized in later years, what was really amazing was the teaching staff. I had almost every discipline, they were very knowledgeable in their subjects, and great motivators. For many years, I've had a local artist's picture of the school hanging in my bedroom, and every time I glance at it, I'm reminded again of how fortunate I was to have my early schooling there. In subsequent years, I acquired a BS in Chemistry, an MS in Analytical Chemistry, and an MS in Operations Research, but never had any more talented teachers than the ones I started out with.

Thanks for motivating me to write to you about them.

Jack E. Garrett

* * * *

Dear Dr. Schmidt,

I must disagree with your response to the September letter from John Jarrell in Brass Tacks. You fault him for having a political bias. I certainly do have one, and I would presume that you do also. If you should choose not to print a letter with a political bias, I could easily understand that, but having printed it, and then faulting him for it seems suspect.

Am I defending his viewpoint? Absolutely, since I have been saying exactly the same things for quite a while now. And I am sure that somewhere in here I have a spelling error or two, but does his error somehow lessen the point he was making?

The first thing I read in *Analog* is your editorial, and it sometimes worries me that I agree with you 98% of the time, and am one of your fans for that alone, aside from the excellent magazine. But I honestly believe that in this response, you blew it big time.

Don Manyette

* * * *

No, I did not fault him for having a political bias, nor do I consider my response a personal attack (as at least one other reader claimed). I explicitly acknowledged that his general points were good ones, which was the main reason I printed the letter. What bothered me was that all his specific illustrations seemed to be chosen to expound a particular political bias, to the point where it seemed that that, not promoting more careful thought, was the primary purpose of the letter. I may have been mistaken in that impression, but it's the one I got, and I got it strongly. And that would have bothered me regardless of which political bias he showed.

* * * *

Clan Father (I mean Dr. Schmidt),

I was so intrigued by the first half of Barry Longyear's "Turning The Grain" that the minute the September issue arrived, I sat down and finished it.

That was a great story, full of interesting Native American mythology, an imaginative description of early humans, very earthy details, touching relationships, and a happy ending that I didn't quite expect. When I finished reading it, my spirits were raised.

Time travel is a very old theme in science fiction, and could be overworked, but "Time Spanning" as Barry did it was fresh and exciting. Donald Moffit's use of parallel universes for time travel in "The Affair of The Phlegmish Master" (June, 2008) was equally clever.

Analog is without doubt, the very best.

Give my birthday regards to Otto Schmidt. He is my senior by four years.

Bob Stanton

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Reader's Department: **UPCOMING EVENTS** by Anthony Lewis

4-6 December 2009

SMOFCON 27 (Convention runners convention) at Hilton Garden Inn Downtown, Austin, TX. Theme: Time Management. Membership: \$60 until 1 November 2009, more thereafter. Info: www.alamo-sf.org/smofcon27/; P.O. Box 27277, Austin, TX 78755-2277

15-18 January 2010

ARISIA '10 (New England SF conference) at Hyatt Regency Hotel, Cambridge, MA. Artist Guest of Honor: Sarah Clemens; Fan Guests of Honor: Kevin Roche & Andy Trembley; Musical Guest of Honor: SJ Tucker (Skinny White Chick); Writer/Editor Guest of Honor: Gardner Dozois. Memberships: \$40 until 30 September 2009. Info: www.arisia.org; info@arisia.org; Box 391596, Cambridge, MA 02139.

Late January 2010

VERICON X (Harvard University SF conference) at Harvard Yard, Harvard, Cambridge, MA. Info: Harvard-Radcliffe Science Fiction Association, Student Organizations Center, 59 Shepard St., Box 93, Harvard University, Cambridge, MA 02138

12-14 February 2010

BOSKONE 47 (New England SF conference) at Waterfront Westin, Boston, MA. Guest of Honor: Alastair Reynolds; Official Artist: John Picacio; Special Guest: Tom Shippey; Featured Filker: Mary Crowell; Hal Clement Science Speaker: Vernor Vinge; NESFA Press Guest: Michael Whelan. Membership: \$47 until Mid-January 2010. Info: www.nesfa.org/boskone/; info-b47@boskone.org; Boskone 47, Box 809, Framingham, MA 01701; 617.776 (fax)

2-6 September 2010

AUSSIECON FOUR (68th World Science Fiction Convention) at Melbourne Convention and Exhibition Centre, Melbourne, Victoria, Australia. Guest of Honor: Kim Stanley Robinson; Artist Guest of Honor: Shaun Tan; Fan Guest of Honor: Robin Johnson. Membership from 1 January 2009 until some later date (see website for latest details): AUD 210, USD 175, CAD 185, GBP 100, EUR 120, JPY 16000; supporting membership AUD 70, USD 50, CAD 50, GBP 25, EUR 35, JPY 4900. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. Info: www.aussiecon4.org.au/, info@aussiecon4.org.au, GPO Box 1212, Melbourne, Victoria, AUSTRALIA 3001

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Running a convention? If your convention has a telephone or fax number, e-mail address, or web page, please let us know so that we can publish this information. We must have your information in hand SIX months before the date of your convention.

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Attending a convention? When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an International Reply Coupon if the convention is in a different country.

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